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FLOOD INSURANCE STUDY

ORIGINAL

CITY OF CONROE, TEXAS
MONTGOMERY COUNTY

APRIL 15, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER - 480484

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Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index
Flood Insurance Rate Map

FLOOD INSURANCE STUDY
CITY OF CONROE, TEXAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Conroe, Montgomery County, Texas, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in their efforts to promote sound flood plain management. Minimum flood plain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses in this study represent a revision of the original analyses by Black & Veatch, Consulting Engineers, for the Federal Emergency Management Agency (FEMA), under Contract No. H-3814. The updated version for areas annexed by the City of Conroe was prepared by the Soil Conservation Service (SCS) under agreement with FEMA. This work was completed in October 1984.

1.3 Coordination

A search for basic data was made at all levels of government. The Director of Community Development provided city maps, planning reports, proposed channel improvements, and historical flooding background.

The Texas State Highway Department provided bridge information used in the hydraulic analyses. The Texas Water Development Board provided U. S.

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Geological Survey (USGS) flood prone maps, background information, and assistance in locating sources of data used in the study. The SCS provided Montgomery County surface soils information.

Coordination for this study included meetings with city officials on March 19, 1975, and July 11, 1975, for the purpose of data collection. A meeting was held with the Director of Community Development on November 11, 1975, to discuss study procedures. On February 26, 1976, a final Consultation and Coordination Officer's (CCO) meeting, attended by representatives of the city and FEMA, was held to review the results of the study.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Conroe, Montgomery County, Texas. The area of study is shown on the Vicinity Map (Figure 1).

The following streams were studied by detailed methods: Live Oak Branch, from approximately 100 feet above Live Branch Road to the downstream corporate limits; Alligator Creek, from approximately 50 feet above State Route 336 to the downstream corporate limits; West Branch Alligator Creek, from approximately 50 feet above State Highway 336 to its confluence with Alligator Creek; West Fork, West Branch Alligator Creek, from approximately 100 feet above State Highway 336 to its confluence with West Branch Alligator Creek; Grand Lake Creek, from approximately 50 feet below Shady Grove Avenue to the extreme downstream corporate limits; Silverdale Creek, from approximately 400 feet above Wagers Street to the extreme downstream corporate limits; Stewarts Creek, for its entire stream length within the community; Possum Branch, from Edgar Street to its confluence with Stewarts Creek; North Fork Stewarts Creek, from approximately 0.12 mile upstream of Hilbig Road to its confluence with Stewarts Creek; Stewarts Creek Tributary No. 1, for its flooding affecting the northern portion of the community; and Little Caney Creek, from the Atchison, Topeka, and Santa Fe Railway to a point approximately 1,200 feet downstream.

In the updated study, flooding was added for Alligator Creek, Stewarts Creek, Stewarts Creek Tributary No. 1, and Little Caney Creek to incorporate annexed areas. The hydrologic and hydraulic analyses for Grand Lake Creek and Silverdale Creek were revised to incorporate annexations and more recent information.

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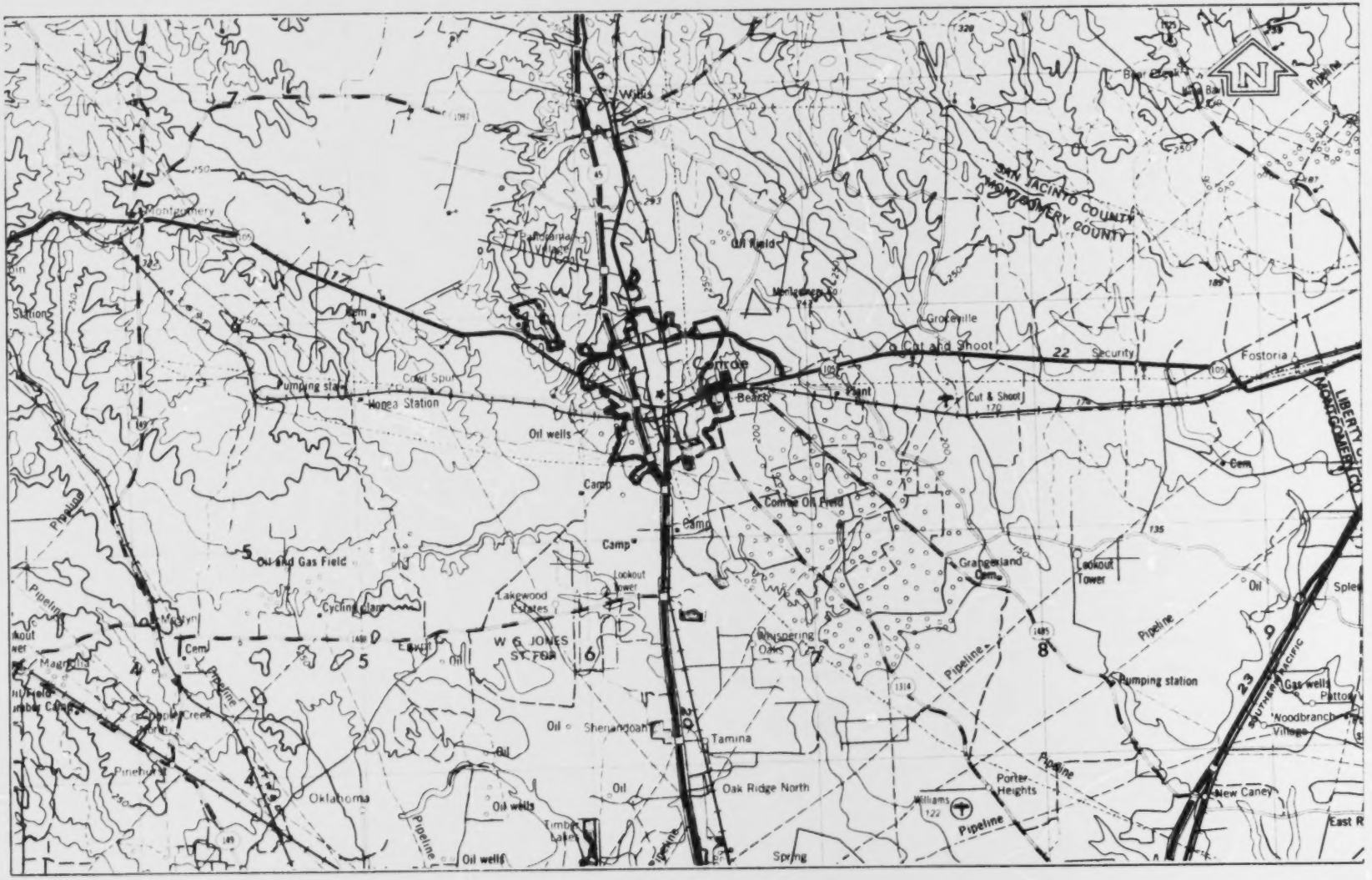

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX
(MONTGOMERY CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

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Portions of the city are subject to shallow flooding due to localized ponding or inadequate surface drainage. These areas have not been included in this study.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

2.2 Community Description

Conroe is located in central Montgomery County, in a rolling forested area, approximately 37 miles north of Houston. Major highways passing through Conroe include Interstate Highway 45, U. S. Route 75, and State Route 105. The Gulf, Colorado, and Santa Fe Railroad is oriented on an east/west path through the city, and the Missouri Pacific Railroad runs north/south.

The 1970 population of Conroe was 16,931. Conroe is one of the state's fastest growing areas with an 84 percent population increase since 1960 due primarily to the Houston metropolitan population expansion (Reference 1). The population trend is expected to continue in the foreseeable future.

The watersheds of the Conroe area drain south to the West Fork San Jacinto River. The confluence of Alligator Creek is located approximately 3 miles southwest of Conroe, and the Stewarts Creek confluence lies approximately 3.5 miles south of the city. The Alligator Creek drainage area consists of 4.13 square miles above the southwest corporate limits. The Stewarts Creek drainage area is 16.78 square miles above the Foster Drive bridge.

Light commercial development is located on the flood plains of Alligator Creek and Grand Lake Creek along Interstate Route 45 and on the flood plains of Stewarts Creek and Possum Branch along State Route 105. Residential structures are located within the flood plains of Live Oak Branch, West Branch Alligator Creek, and Possum Branch. There is sparse residential development along Stewarts Creek and North Fork Stewarts Creek.

The topography of the area is nearly flat with some hills that are covered with timber. Ground elevations vary from approximately 260 feet to approximately 155 feet, with the average business district elevation at approximately 215 feet (References 2 and 3).

Topsoil ranges from sandy soils with a clayey lower region appearing in the upper three-quarters of the city to sandy soils with loamy lower regions located in the lower city quadrant. The drainage properties of the soils within the study area are good (Reference 4).

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Climatic information for Conroe indicates an average annual rainfall of 47.65 inches with yearly temperature variations from 6 degrees Fahrenheit (°F) to 107°F. The mean daily temperature ranges between a low of 56.5°F to a high of 79.5°F (Reference 5).

2.3 Principal Flood Problems

The Conroe area is subject to tropical storms. Rainfall over extended time periods is not uncommon for the area. Historically, Stewarts Creek and Alligator Creek have been the major threats to flooding. The worst flooding occurred in 1973 when these streams flooded three times within the first seven months (Reference 6).

2.4 Flood Protection Measures

Construction of Interstate Route 45 through the western section of the city resulted in the channelization of some sections of Alligator Creek. Drainage improvements have been proposed and preliminary plans drawn for Alligator Creek from the West Branch origin at Loop Highway 336 to the West Fork San Jacinto River (Reference 7). Flooding in the area could also be reduced by removing debris from around culverts and providing an unobstructed path along Alligator Creek for drainage of excess quantities of water.

Channel improvements in the vicinity of West Lewis Street and State Route 105 were included in the analyses for Alligator Creek. There exists the potential for reducing future flood peaks if similar improvements are initiated and if channel and overbank areas are cleared of undergrowth, trees, and debris. A systematic channel maintenance program is herein recommended for the streams studied in this report.

At the time this study was made, channel improvements were completed or were under construction on the reach of Alligator Creek north from State Route 105 to the confluence with East and West Branches of Alligator Creek, extending east to U. S. Route 75 and west to Interstate Route 45. In addition, funding for proposed Alligator Creek channel improvements between Interstate Route 105 and Old Montgomery Road has been approved. Plans for the latter improvements have not been finalized; therefore, they were not included in this study. No other flood control measures are presently planned.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected

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to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood w h qu 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Peak discharges for floods of the 10-, 50-, and 100-year recurrence intervals for the streams studied by detailed methods except Grand Lake Creek, Silverdale Creek, Stewarts Creek Tributary No. 1, and Little Caney Creek were computed using National Weather Bureau rainfall frequency-duration data and the rainfall-runoff relationships developed by the SCS (References 8 and 9). These computations included consideration of the percentage of watershed developed, soil classifications, length of overland flow, and other pertinent basin characteristics as determined from published documents and field reconnaissance. Discharges were computed for interior watershed locations by the ratio-of-areas technique when considered necessary for enhancing the degree of definition for backwater calculations. Discharges for 500-year floods were determined by straight-line extrapolation of log-probability graphs of flood discharges computed for frequencies up to 100 years.

In the updated study, the discharges for Grand Lake Creek, Silverdale Creek, Stewarts Creek Tributary No.1, and Little Caney Creek were determined using the SCS computer model in Technical Release No. 20 (Reference 10).

A summary of the drainage area-peak discharge relationships for Grand Lake Creek, Silverdale Creek, Stewarts Creek Tributary No. 1, and Little Caney Creek is shown in Table 1, "Summary of Discharges." For purposes

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of comparison, drainage area-peak discharge relationships for the streams studied by detailed methods are shown in Figure 2, "Frequency-Discharge, Drainage Area Curves" (References 11 and 12).

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
GRAND LAKE CREEK					
At cross section A	1.13	301	702	950	1,675
At Gladstell Street	0.49	189	420	552	927
At Interstate Route 45	0.40	170	362	473	802
At School Road	0.29	142	288	371	609
At Hickerson Street	0.23	116	226	292	499
SILVERDALE CREEK					
At Interstate Route 45	1.43	489	1,035	1,348	2,199
At Foster Drive	0.63	237	497	655	1,112
At Marilyn Street	0.29	107	228	300	510
At Silverdale Drive	0.23	93	198	260	439
At Wagers Street	0.20	86	182	239	401
STEWARTS CREEK TRIBUTARY NO. 1					
At Missouri Pacific Railroad	2.05	175	630	936	1,898
LITTLE CANEY CREEK					
At a point approximately 2,000 feet above Atchison, Topeka, and Santa Fe Railway	0.65	111	376	550	1,091

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Cross sections for the backwater analyses for each stream studied in detail were field surveyed and were located at close intervals in the vicinity of bridges and culverts in order to compute the significant backwater effects of these structures in the urbanized areas. Supplemental cross section information was obtained from topographic maps (Reference 13).

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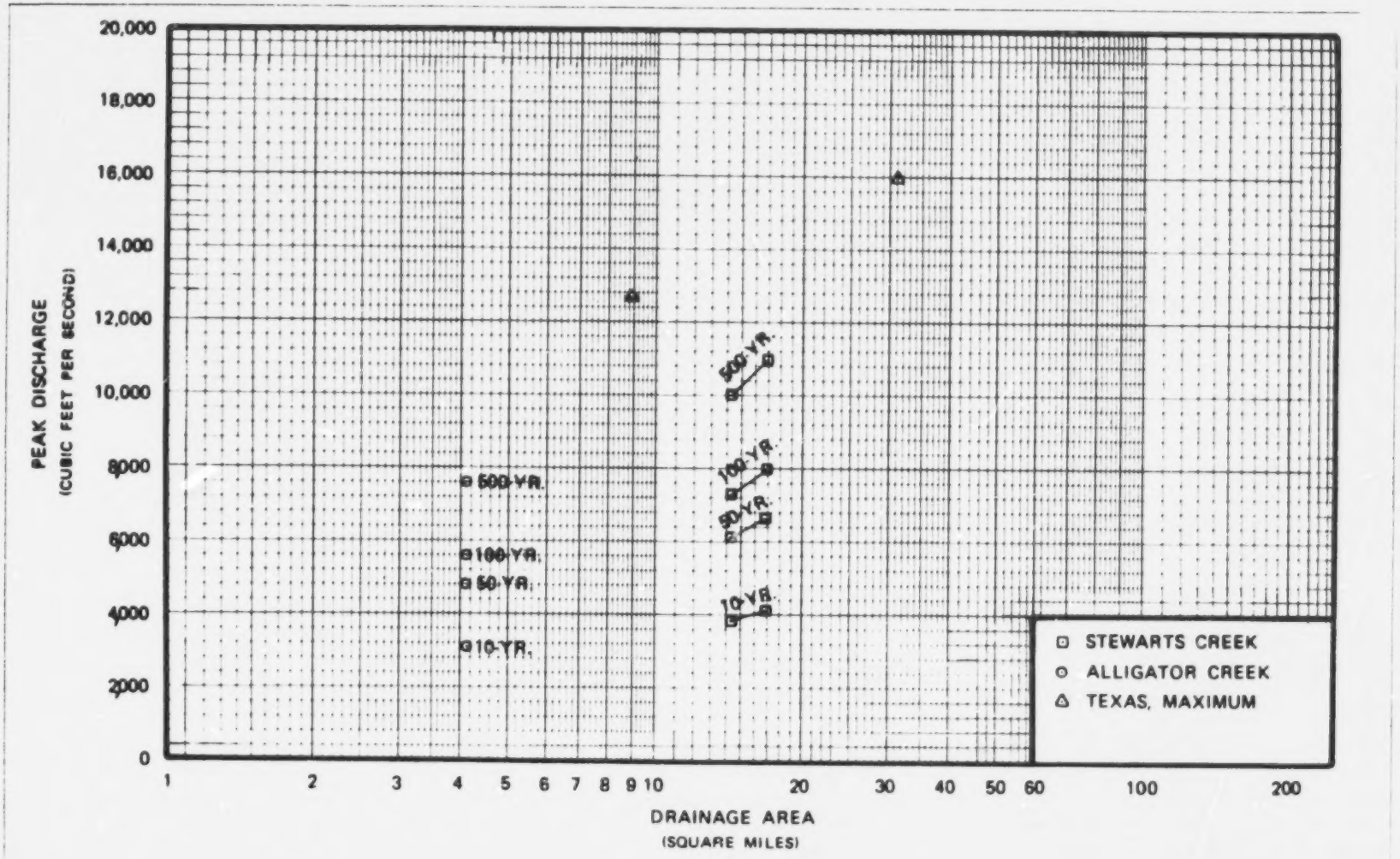

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX
(MONTGOMERY CO.)

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

ALLIGATOR CREEK AND STEWARTS CREEK

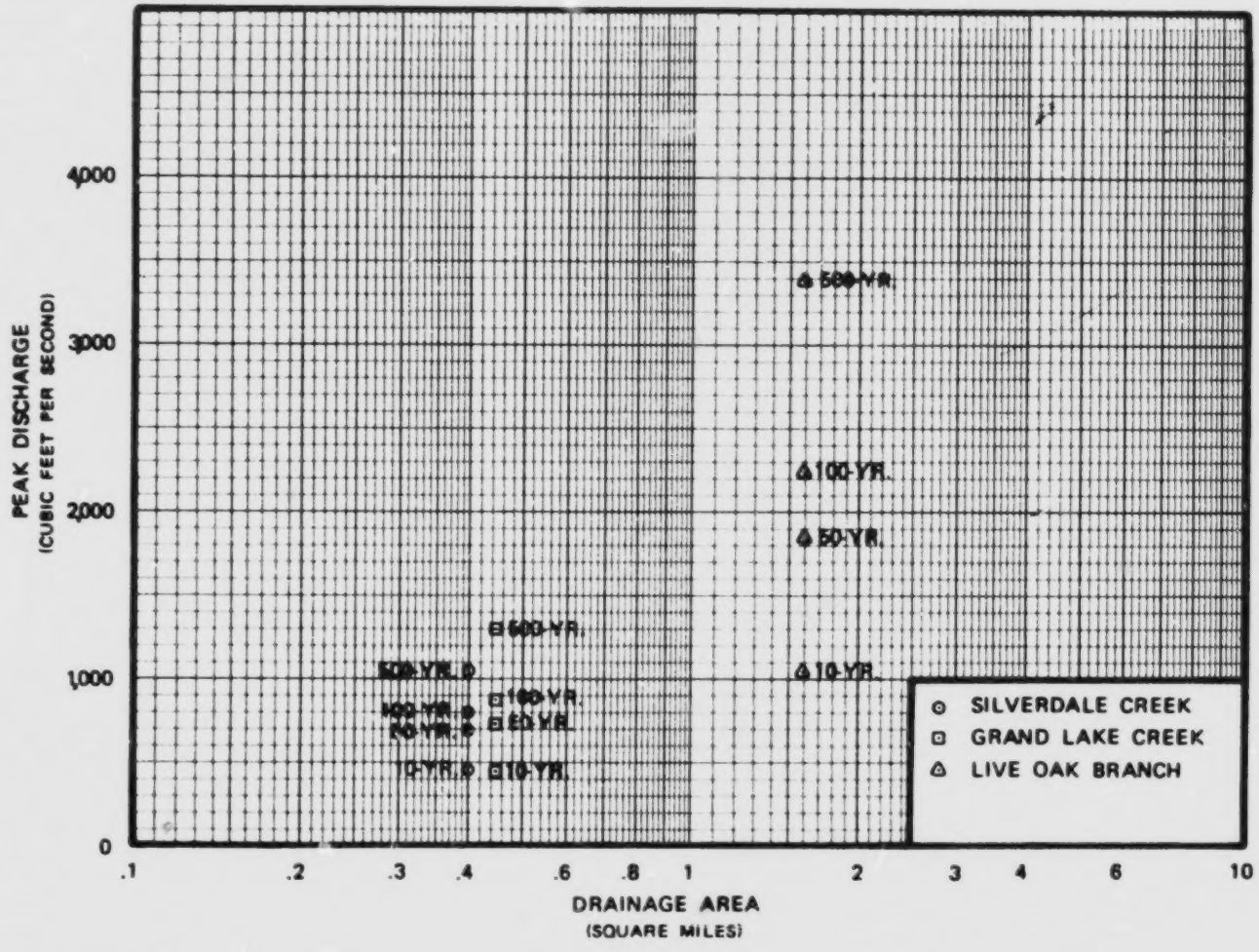

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX
(MONTGOMERY CO.)

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

GRAND LAKE CREEK , SILVERDALE CREEK AND LIVE OAK BRANCH

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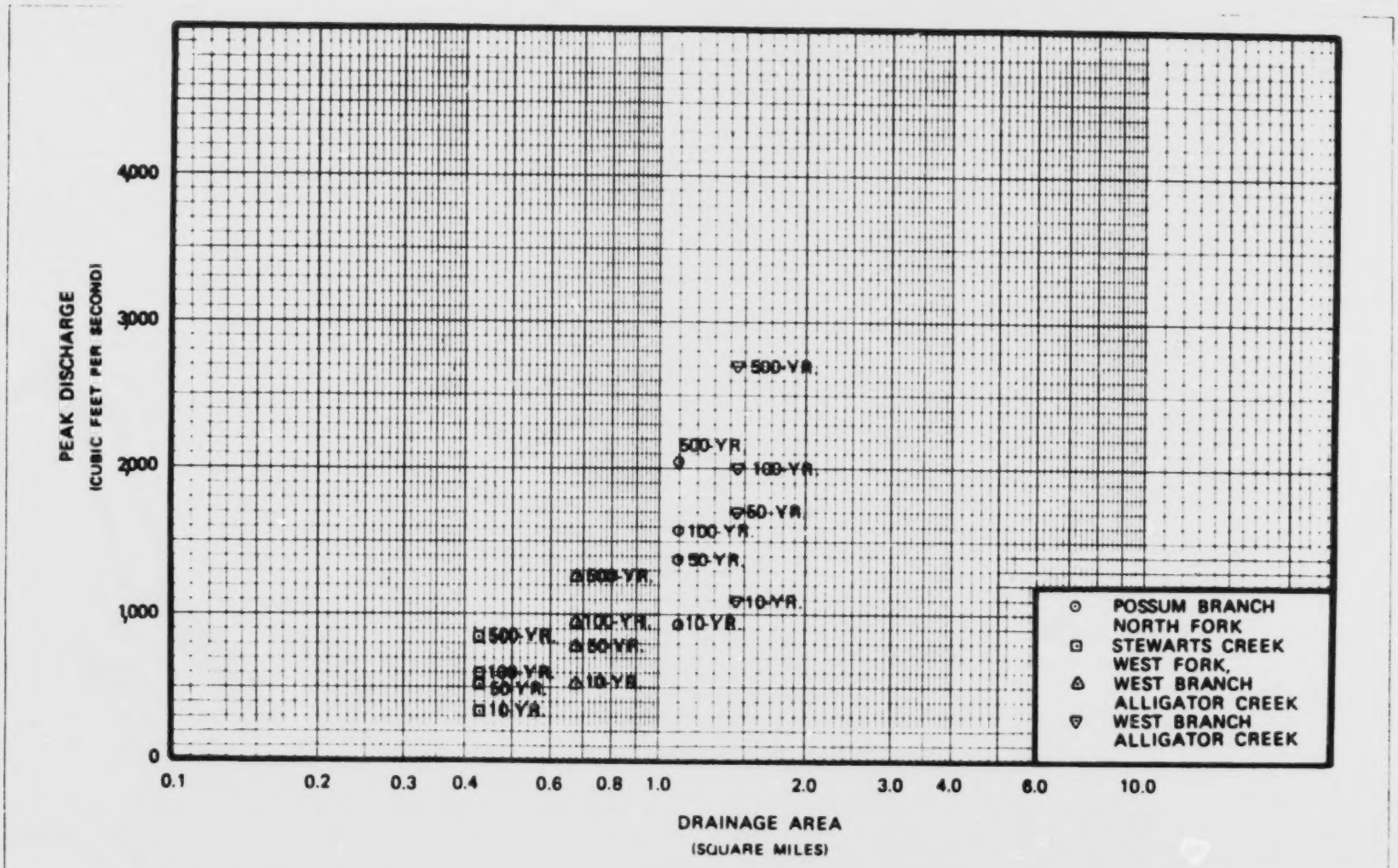

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX
(MONTGOMERY CO.)

10

FREQUENCY-DISCHARGE, DRAINAGE AREA CURVES

POSSUM BRANCH, NORTH FORK STEWARTS CREEK, WEST FORK, WEST BRANCH ALLIGATOR CREEK, WEST BRANCH ALLIGATOR CREEK

Channel roughness factors (Manning's "n") for these computations were assigned on the basis of field inspection of flood plain and channel areas. Channel "n" values ranged from 0.015 to 0.075 for the streams studied by detailed methods, and overbank "n" values ranged from 0.030 to 0.150.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Water-surface elevations of floods of the selected recurrence intervals for the streams studied by detailed methods except Grand Lake Creek, Silverdale Creek, Stewarts Creek Tributary No. 1, and Little Caney Creek were computed using the COE HEC-2 step-backwater computer program (Reference 14). The water-surface elevations for Grand Lake Creek, Silverdale Creek, Stewarts Creek Tributary No. 1, and Little Caney Creek were developed from the SCS WSP-2 computer program (Reference 15). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. The starting elevations for the streams studied by detailed methods except Stewarts Creek Tributary No. 1 and Little Caney Creek were determined by the slope/area method. The starting water-surface elevations for Stewarts Creek Tributary No. 1 and Little Caney Creek were taken from the Flood Insurance Study for the unincorporated areas of Montgomery County (Reference 16).

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the

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base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail (except for the areas listed below), the 100- and 500-year flood plain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps (Reference 13).

Flood boundaries for the annexed area on Alligator Creek were delineated using USGS topographic maps (Reference 17). Flood boundaries for the annexed areas on Grand Lake Creek, Silverdale Creek, Stewarts Creek Tributary No. 1, and Little Caney Creek were delineated using the Flood Insurance Study for the unincorporated areas of Montgomery County (Reference 16).

The 100- and 500-year flood plain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year flood plain boundaries are close together, only the 100-year flood plain boundary has been shown. Small areas within the flood plain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

4.2 Floodways

Encroachment on flood plains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood plain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2). Portions of the floodway widths for Alligator Creek, Grand Lake Creek, and Stewarts Creek extend beyond the corporate limits.

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
						(FEET NGVD)		
Live Oak Branch								
A	5,380[1]	122	675	3.3	182.0	182.0	183.0	1.0
B	6,350[1]	207	1,376	1.5	187.4	187.4	188.2	0.8
C	6,970[1]	100	470	4.2	189.0	189.0	190.0	1.0
D	7,430[1]	150	442	4.2	189.5	189.5	190.5	1.0
E	8,410[1]	124	567	3.1	195.5	195.5	196.2	0.7
Alligator Creek								
A	1,980[2]	516[3]	2,989	1.8	166.2	166.2	166.6	0.4
B	480[2]	400[3]	1,586	3.2	167.6	167.6	168.4	0.8
C	70[1]	159	971	5.3	169.5	169.5	170.3	0.8
D	1,840[1]	206	1,253	3.7	176.9	176.9	177.2	0.3
E	2,730[1]	480	2,477	1.6	179.8	179.8	180.6	0.8
F	3,710[1]	66	501	7.8	180.0	180.0	180.6	0.6
G	5,600[1]	66	254	6.7	183.5	183.5	183.6	0.1
H	7,110[1]	60	349	3.5	195.1	195.1	196.0	0.9
I	7,600[1]	57	281	4.3	199.1	199.1	200.0	0.9
J	8,370[1]	33	190	6.4	203.4	203.4	203.6	0.2
K	9,110[1]	40	306	3.2	209.6	209.6	210.6	1.0
L	9,960[1]	57	284	3.4	212.3	212.3	213.3	1.0
M	13,130[1]	27	135	4.8	225.9	225.9	226.9	1.0
N	13,700[1]	36	169	3.8	228.5	228.5	229.3	0.8
O	14,790[1]	28	93	5.7	233.0	233.0	233.5	0.5

[1]Feet above Old Montgomery Road
[2]Feet below Old Montgomery Road
[3]This width extends beyond corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF CONROE, TX
(MONTGOMERY CO.)

FLOODWAY DATA

LIVE OAK BRANCH–ALLIGATOR CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
West Branch Alligator Creek								
A	1,350[1]	291	1,573	1.2	184.8	184.8	185.0	0.2
B	2,520[1]	265	1,203	0.6	187.2	187.2	187.4	0.2
C	3,840[1]	28	288	2.5	192.1	192.1	192.9	0.8
D	5,260[1]	67	221	2.6	198.2	198.2	198.5	0.3
E	6,670[1]	17	76	4.6	206.4	206.4	207.2	0.8
F	7,620[1]	20	73	3.8	211.9	211.9	212.9	1.0
G	8,650[1]	22	64	2.5	221.9	221.9	222.2	0.3
West Fork, West Branch Alligator Creek								
A	415[2]	108	422	2.2	184.8	184.8	185.0	0.2
B	1,550[2]	78	308	2.6	190.3	190.3	191.2	0.9
C	2,480[2]	61	140	3.9	196.0	196.0	196.9	0.9
D	3,640[2]	13	62	5.6	198.9	198.9	199.5	0.6
E	4,010[2]	18	117	2.9	203.0	203.0	203.8	0.8
F	4,790[2]	13	59	5.8	207.4	207.4	208.0	0.6
G	6,210[2]	13	44	3.9	217.8	217.8	218.1	0.3

[1]Feet above confluence with Alligator Creek

[2]Feet above confluence with West Branch Alligator Creek

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Grand Lake Creek								
A	16,140[1]	116[3]	504	1.9	144.1	144.1	145.1	1.0
B	20,124[1]	57	133	4.1	157.7	157.7	157.7	0.0
C	20,434[1]	36	185	2.9	161.5	161.5	162.0	0.5
D	21,034[1]	29	159	3.2	162.4	162.4	163.4	1.0
E	21,344[1]	41	307	1.5	164.8	164.8	165.8	1.0
F	22,824[1]	23	105	3.5	171.9	171.9	172.4	0.5
G	22,884[1]	30	141	2.6	173.2	173.2	173.9	0.7
H	23,134[1]	10	61	5.6	174.5	174.5	175.5	1.0
I	23,389[1]	19	65	5.0	176.1	176.1	176.1	0.0
J	23,599[1]	64	293	1.1	177.2	177.2	178.2	1.0
K	23,980[1]	24	97	3.0	178.2	178.2	178.7	0.5
L	24,060[1]	23	94	3.1	179.5	179.5	180.0	0.5
M	24,770[1]	21	69	3.2	184.5	184.5	185.0	0.5
Silverdale Creek								
A	14,200[2]	42	195	6.0	142.7	142.7	143.4	0.7
B	19,110[2]	34	129	5.1	164.2	164.2	165.2	1.0
C	19,170[2]	104	533	1.2	166.2	166.2	167.2	1.0
D	20,530[2]	85	269	1.4	173.1	173.1	174.1	1.0
E	20,590[2]	113	495	0.8	173.7	173.7	174.7	1.0
F	21,260[2]	59	237	1.3	175.5	175.5	176.5	1.0
G	21,301[2]	48	172	1.7	175.6	175.6	176.6	1.0
H	22,491[2]	17	85	3.1	181.9	181.9	182.4	0.5

[1]Feet above confluence with Grand Lake

[2]Feet above confluence with Stewarts Creek

[3]This width extends beyond corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX

(MONTGOMERY CO.)

FLOODWAY DATA

GRAND LAKE CREEK-SILVERDALE CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Silverdale Creek (continued)								
I	22,552[1]	70	332	0.8	185.3	185.3	186.3	1.0
J	22,852[1]	31	129	1.9	186.0	186.0	186.5	0.5
K	22,912[1]	23	129	1.9	186.8	186.8	187.8	1.0
L	23,282[1]	33	148	1.5	187.1	187.1	187.6	0.5
Stewarts Creek								
A	24,460[2]	126[3]	1,063	4.1	159.2	159.2	160.2	1.0
B	28,900[2]	300	2,427	3.3	170.8	170.8	171.5	0.7
C	30,550[2]	420	3,352	2.2	173.5	173.5	174.2	0.7
D	31,463[2]	500	3,218	2.3	174.8	174.8	175.6	0.8
E	33,142[2]	150[3]	1,033	7.2	176.8	176.8	177.8	1.0
F	33,380[2]	410[3]	3,599	2.1	179.2	179.2	180.0	0.8
G	35,280[2]	350	3,113	2.3	180.3	180.3	181.1	0.8
H	35,950[2]	330	2,538	2.8	182.2	182.2	182.8	0.6
I	37,020[2]	210	1,491	4.8	183.8	183.8	184.4	0.6
J	38,050[2]	400	3,468	2.1	187.3	187.3	188.3	1.0
K	39,201[2]	221	1,525	2.5	189.5	189.5	190.5	1.0
L	43,263[2]	343	1,854	2.1	195.2	195.2	196.2	1.0
M	43,463[2]	519	2,968	1.3	196.4	196.4	197.4	1.0

[1]Feet above confluence with Stewarts Creek
[2]Feet above confluence with West Fork San Jacinto River
[3]This width extends beyond corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF CONROE, TX
(MONTGOMERY CO.)

FLOODWAY DATA

SILVERDALE CREEK-STEWARTS CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Possum Branch								
A	0.227[1]	77	486	3.0	171.2	171.2	172.2	1.0
B	0.521[1]	259	952	1.5	178.2	178.2	179.2	1.0
C	0.696[1]	92	337	4.3	181.3	181.3	182.3	1.0
D	0.732[1]	406	2,781	0.5	187.2	187.2	187.3	0.1
E	0.920[1]	172	841	1.2	187.7	187.7	187.9	0.2
F	1.100[1]	71	253	3.0	190.1	190.1	190.8	0.7
G	1.200[1]	102	277	1.7	193.0	193.0	193.9	0.9
North Fork Stewarts Creek								
A	0.115[1]	35	176	3.5	187.8	187.8	188.7	0.9
B	0.465[1]	19	91	6.7	199.7	199.7	200.3	0.6
C	0.732[1]	25	85	7.2	212.1	212.1	212.5	0.4
D	0.824[1]	26	56	5.2	215.9	215.9	216.7	0.8
E	0.889[1]	33	131	2.2	218.0	218.0	218.9	0.9
Little Caney Creek								
A	37,472[2]	65	230	2.5	187.8	187.8	188.8	1.0

[1]Miles above confluence with Stewarts Creek

[2]Feet above confluence with West Fork San Jacinto River

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX

(MONTGOMERY CO.)

FLOODWAY DATA

POSSUM BRANCH-NORTH FORK STEWARTS CREEK-LITTLE CANEY CREEK

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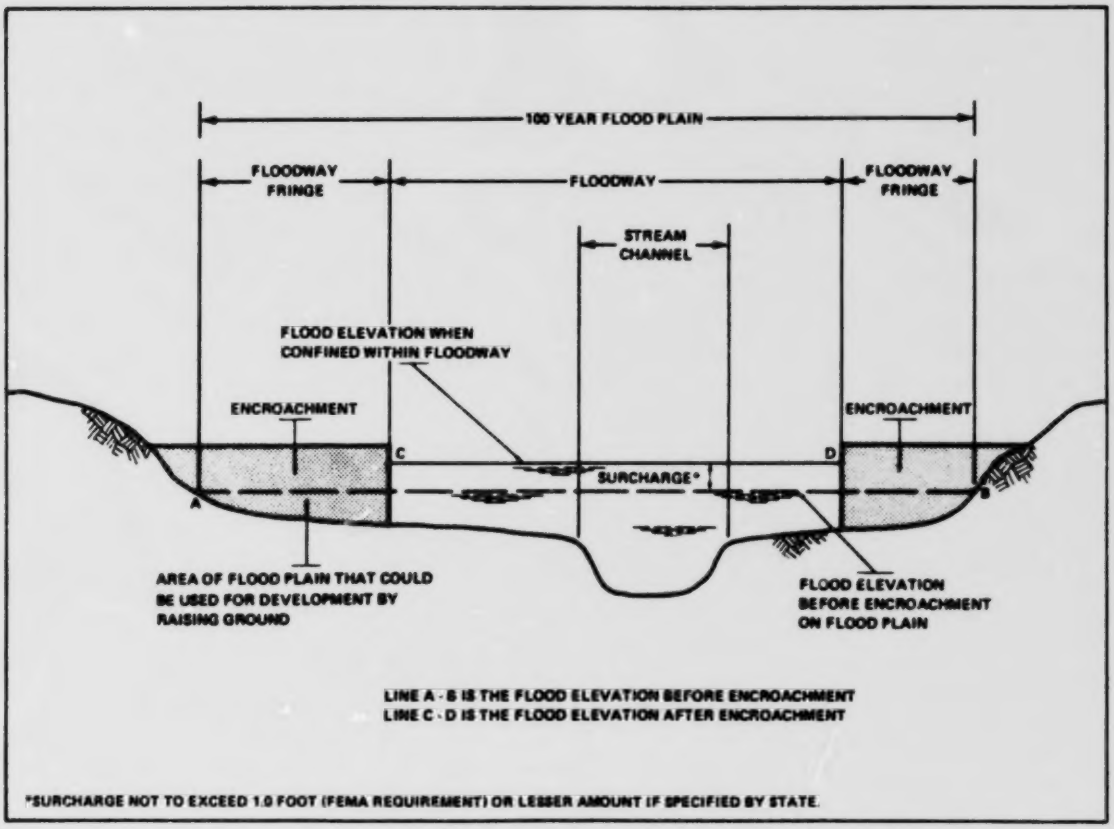
As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year flood plain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year flood plain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 3.


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC Figure 3

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5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail in the City of Conroe.

5.1 Reach Determinations

Reaches are defined as sections of flood plain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of the City of Conroe are shown on the Flood Profiles (Exhibit 1) and summarized in Table 3.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one-half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

Flood insurance zones and zone numbers are assigned based on the type of flood hazard and the FHF, respectively. A unique zone number is

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Live Oak Branch							
Reach 1	03	-1.4	-0.4	+0.9	015	A3	Varies
Alligator Creek							
Reach 1	04	-2.7	-0.8	+1.7	025	A5	Varies
Reach 2	04	-2.1	-0.7	+1.6	020	A4	Varies
Reach 3	02,04	-0.9	-0.2	+0.5	010	A2	Varies
West Branch Alligator Creek							
Reach 1	02,04	-2.4	-0.4	+0.4	025	A5	Varies
Reach 2	02,04	-0.9	-0.3	+0.5	010	A2	Varies
West Fork, West Branch Alligator Creek							
Reach 1	04	-2.0	-0.3	+0.5	020	A4	185
Reach 2	04	-1.3	-0.3	+0.5	015	A3	Varies
Reach 3	04	-0.5	-0.2	+0.4	005	A1	Varies
Reach 4	02,04	-1.4	-0.4	+0.5	015	A3	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF CONROE, TX
(MONTGOMERY CO.)

FLOOD INSURANCE ZONE DATA

LIVE OAK BRANCH-ALLIGATOR CREEK-WEST BRANCH ALLIGATOR CREEK-
WEST FORK, WEST BRANCH ALLIGATOR CREEK

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Grand Lake Creek							
Reach 1	04	-3.1	-0.7	+1.3	030	A6	Varies
Reach 2	04	-2.5	-0.9	+0.8	025	A5	Varies
Silverdale Creek							
Reach 1	04	-1.5	-0.5	+0.9	015	A3	Varies
Reach 2	04	-3.3	-0.3	+0.5	035	A7	Varies
Stewarts Creek							
Reach 1	04	-4.1	-1.1	+2.4	040	A8	Varies
Reach 2	02,04	-2.2	-0.6	+1.3	020	A4	Varies
Reach 3	02	-2.8	-0.9	+2.2	030	A6	Varies
Possum Branch							
Reach 1	04	-0.8	-0.2	+0.5	010	A2	Varies
Reach 2	02,04	-2.1	-0.3	+0.2	020	A4	Varies
Reach 3	04	-0.6	-0.1	+0.2	050	A1	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF CONROE, TX
(MONTGOMERY CO.)

FLOOD INSURANCE ZONE DATA

GRAND LAKE CREEK-SILVERDALE CREEK-STEWARTS CREEK-POSSUM BRANCH

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
North Fork Stewarts Creek							
Reach 1	02	-2.0	-0.4	+1.0	020	A4	Varies
Reach 2	02	-0.8	-0.2	+0.5	010	A2	Varies
Stewarts Creek Tributary No. 1							
Reach 1	02	-2.1	-0.7	+1.6	020	A4	223
Little Caney Creek							
Reach 1	02	-1.9	-0.5	+1.2	020	A4	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY
CITY OF CONROE, TX
(MONTGOMERY CO.)

FLOOD INSURANCE ZONE DATA

NORTH FORK STEWARTS CREEK-STEWARTS CREEK TRIBUTARY NO. 1-LITTLE CANEY CREEK

associated with each possible FHF, and varies from 1 for a FHF of 005 to a maximum of 30 for a FHF of 200 or greater.

Zones A1, A2, A3, A4, A5, A6, A7, and A8: Special Flood Hazard Areas inundated by the 100-year flood; with base flood elevations shown, and zones subdivided according to FHFs.

Zone B: Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.

Zone C: Areas of minimal flooding; not subdivided.

Flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community are shown in Table 3.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Conroe is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

The Flood Insurance Study for the unincorporated areas of Montgomery County is currently being prepared (Reference 16). That study will be in complete agreement with this study.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division,

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Federal Emergency Management Agency, Regional Director, Region VI Office, Federal Center, Denton, Texas 76201.

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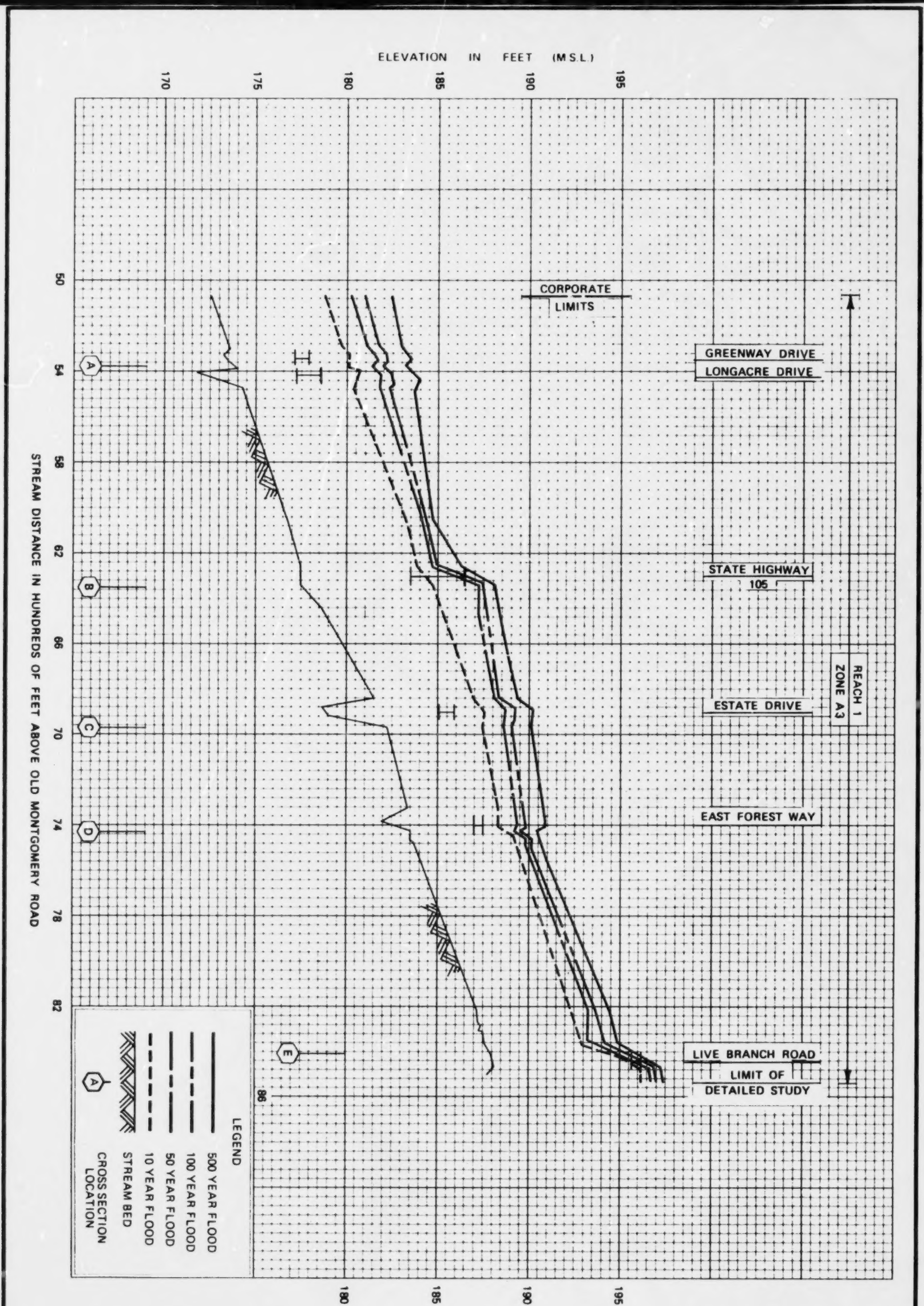

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CITY OF CONROE, TX
(MONTGOMERY CO.)

FLOOD PROFILES

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LIVE OAK BRANCH

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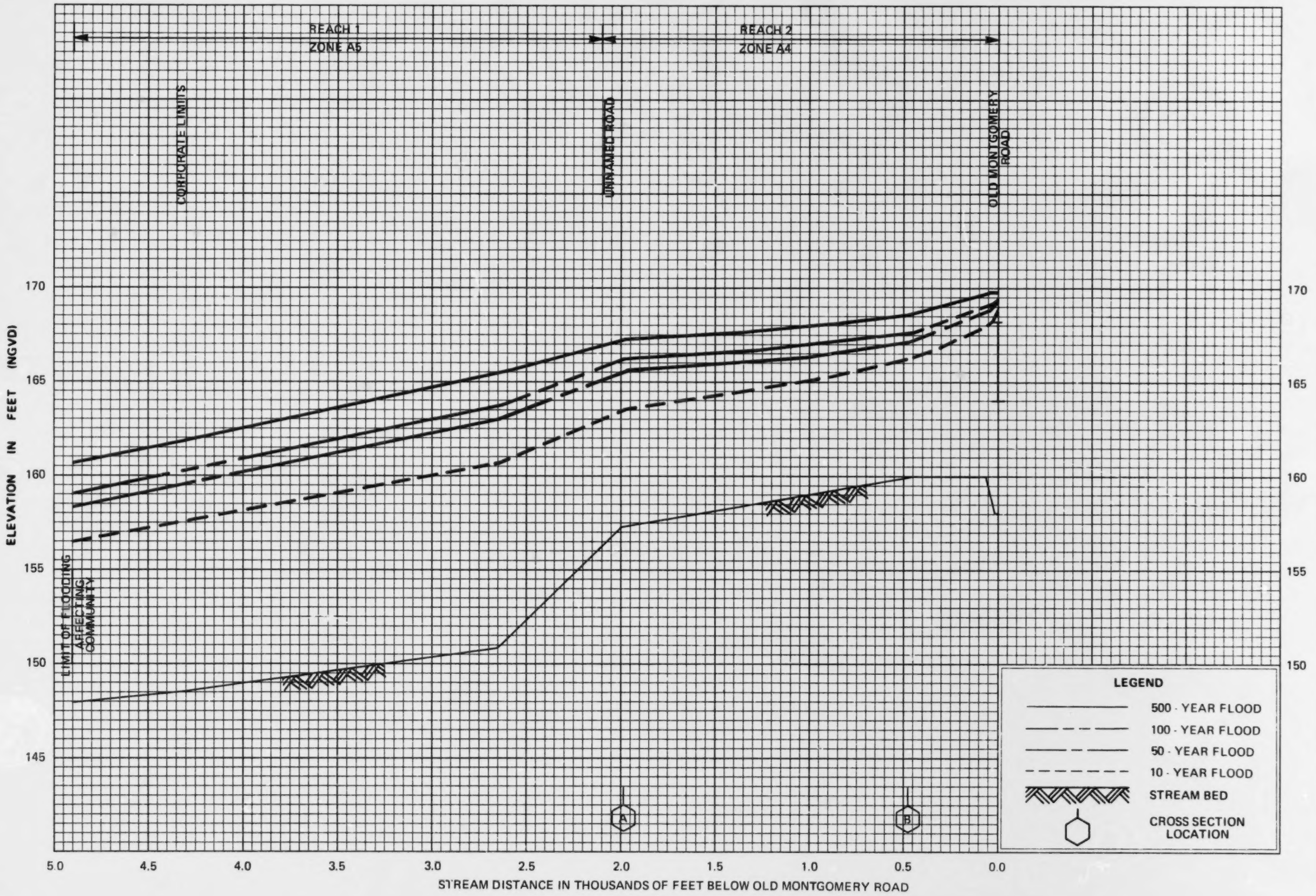

FLOOD PROFILES

ALLIGATOR CREEK

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FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX
(MONTGOMERY CO.)

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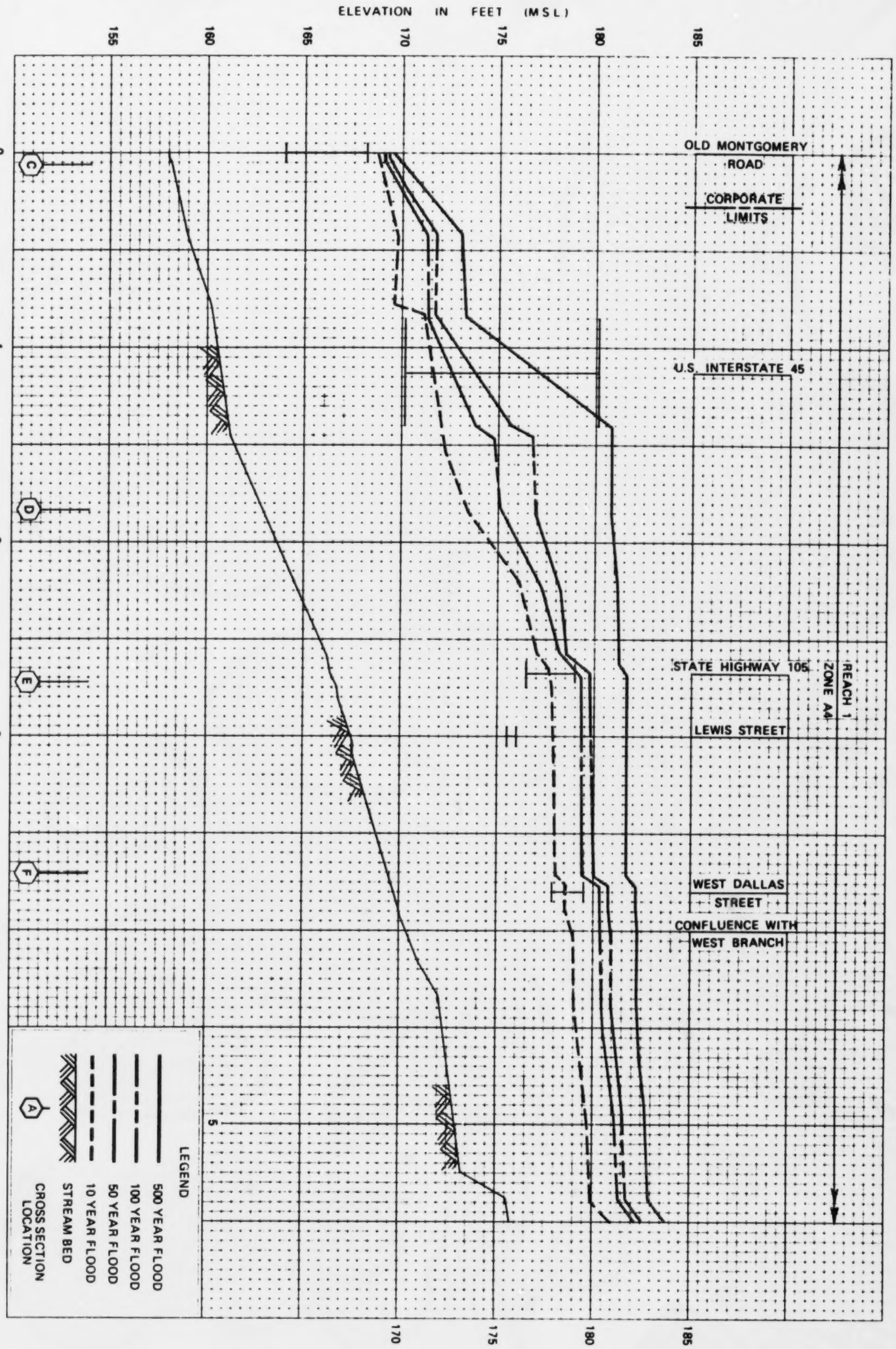

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Federal Insurance Administration

CITY OF CONROE, TX
(MONTGOMERY CO.)

FLOOD PROFILES

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ALLIGATOR CREEK

REACH 1
ZONE A4

REACH 2
ZONE A2

U.S. HIGHWAY 75

NORTH ROBERTSON STREET

CONROE DRIVE

NORTH THOMPSON STREET

PINE SHADOWS DRIVE

PACIFIC STREET

ELEVATION IN FEET (MSL)

215
210
205
200
195
190
185
180
175

6
7
8
9
10

STREAM DISTANCE IN THOUSANDS OF FEET ABOVE OLD MONTGOMERY ROAD

G
H
I
J
K
L

LEGEND

- 500 YEAR FLOOD
- 100 YEAR FLOOD
- 50 YEAR FLOOD
- 10 YEAR FLOOD
- STREAM BED
- A — CROSS SECTION LOCATION

FLOOD PROFILES

ALLIGATOR CREEK

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CITY OF CONROE, TX
(MONTGOMERY CO.)

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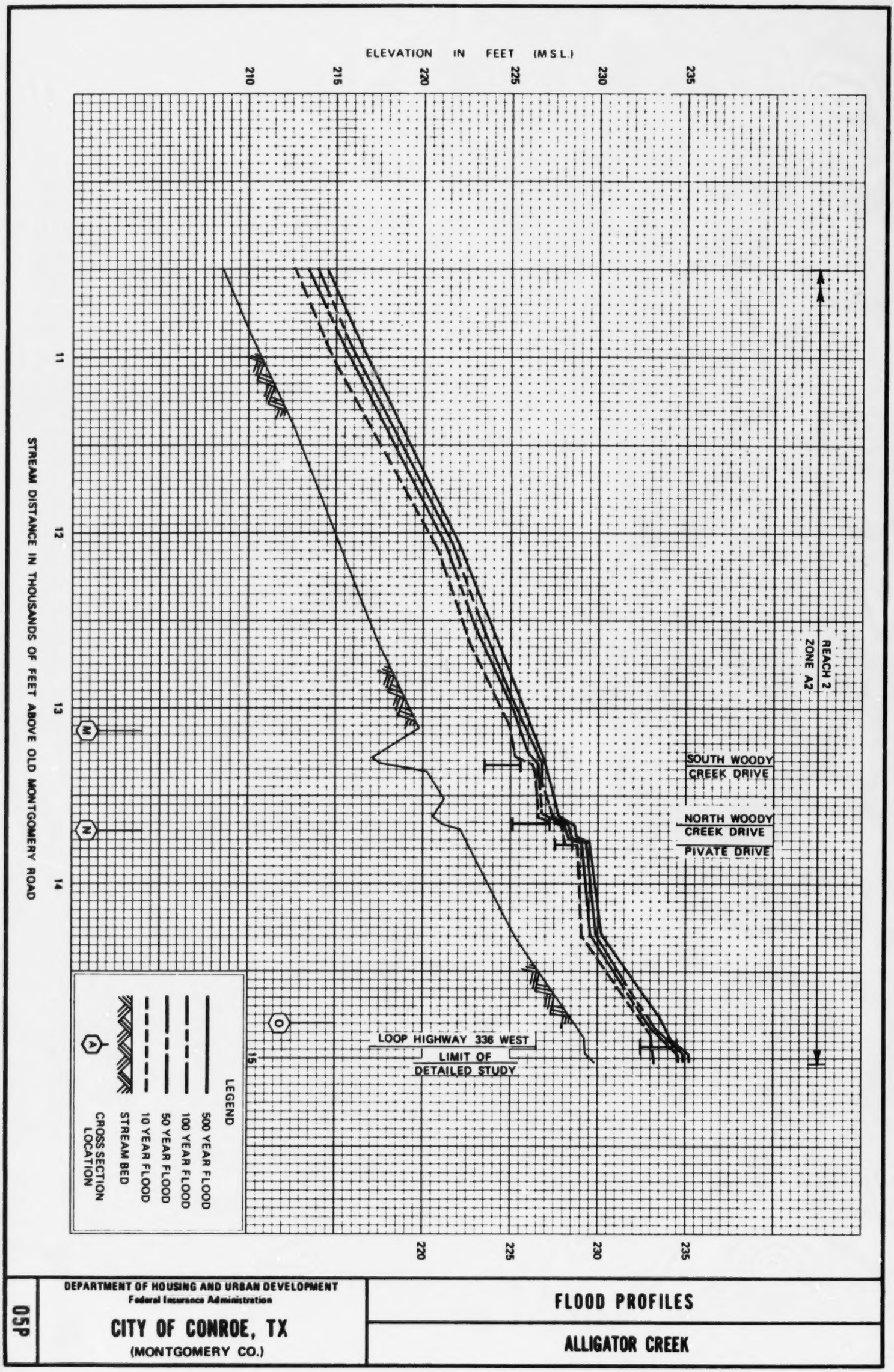

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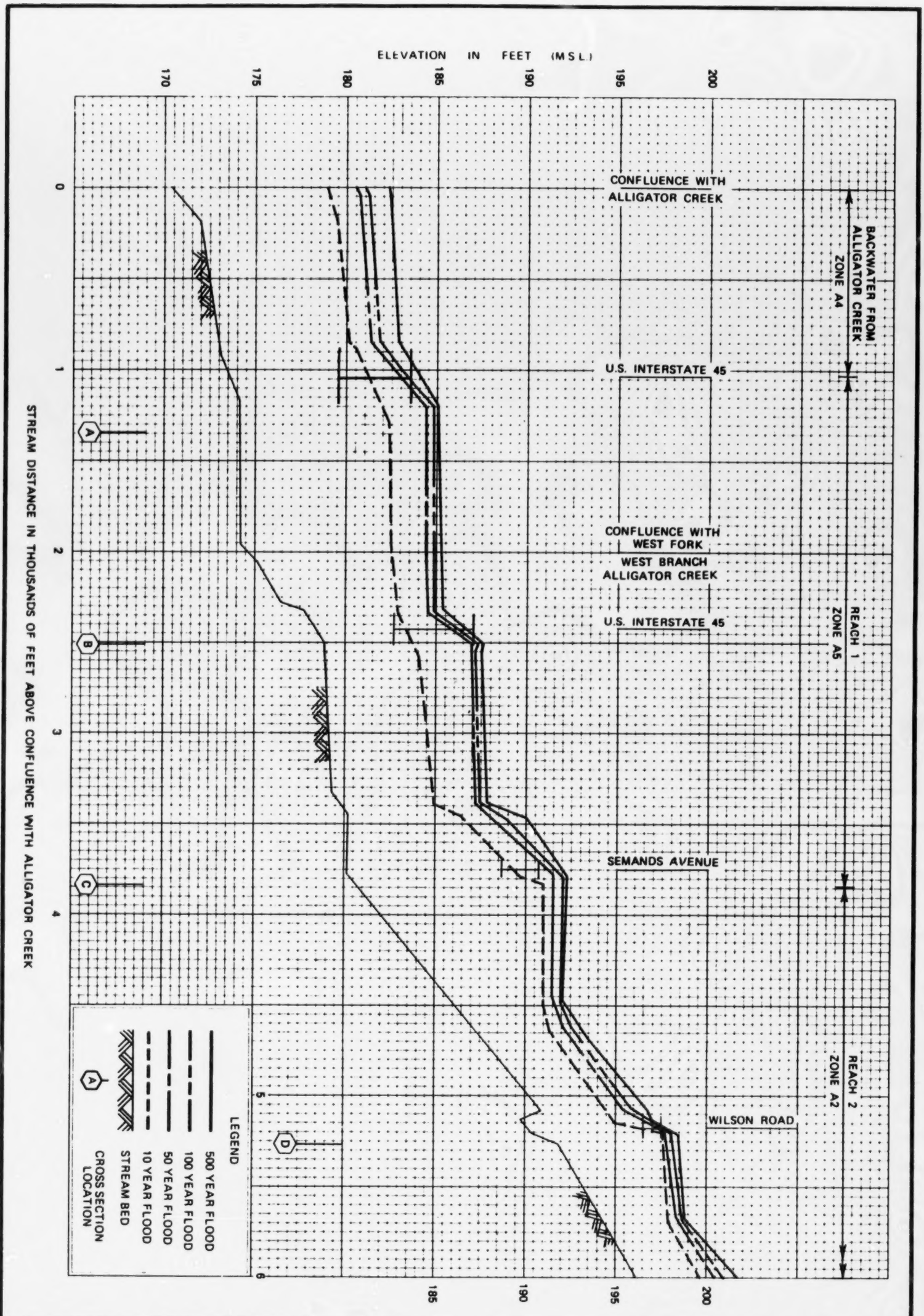
FLOOD PROFILES

ALLIGATOR CREEK



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CITY OF CONROE, TX
(MONTGOMERY CO.)

FLOOD PROFILES

WEST BRANCH ALLIGATOR CREEK

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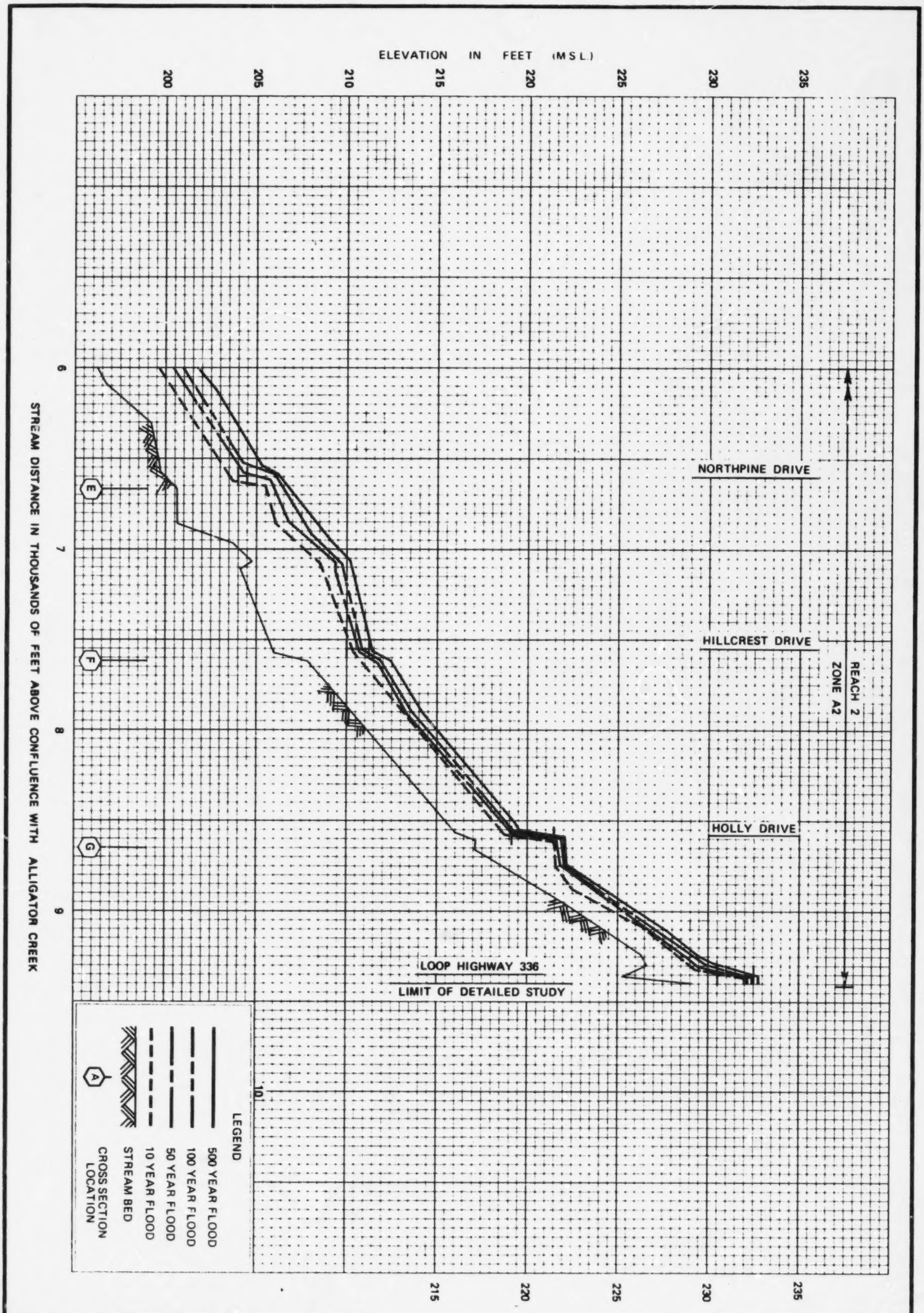

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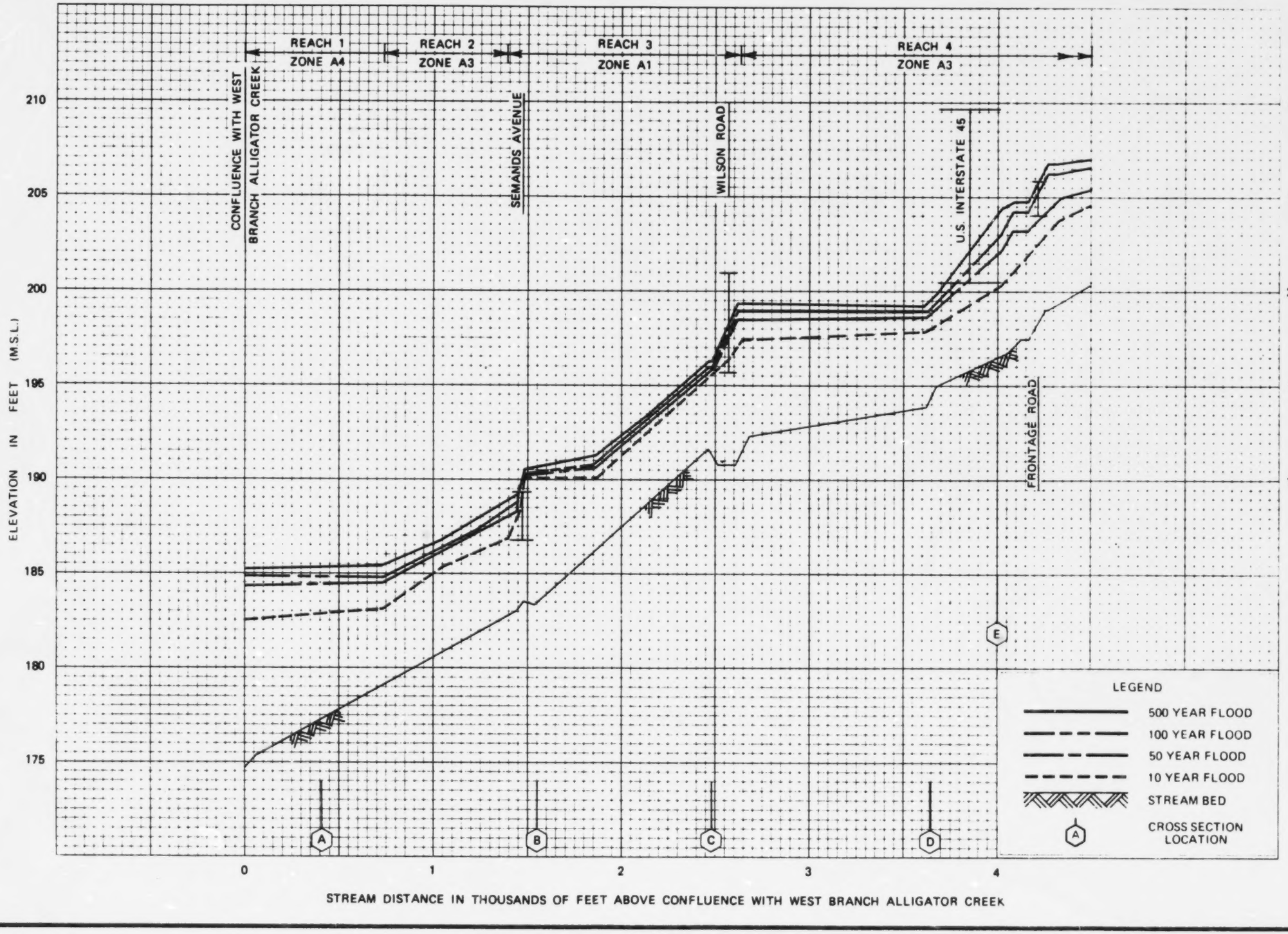
CITY OF CONROE, TX
(MONTGOMERY CO.)

FLOOD PROFILES

WEST BRANCH ALLIGATOR CREEK



FLOOD PROFILES

WEST FORK, WEST BRANCH ALLIGATOR CREEK

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Federal Insurance Administration

CITY OF CONROE, TX
(MONTGOMERY CO.)

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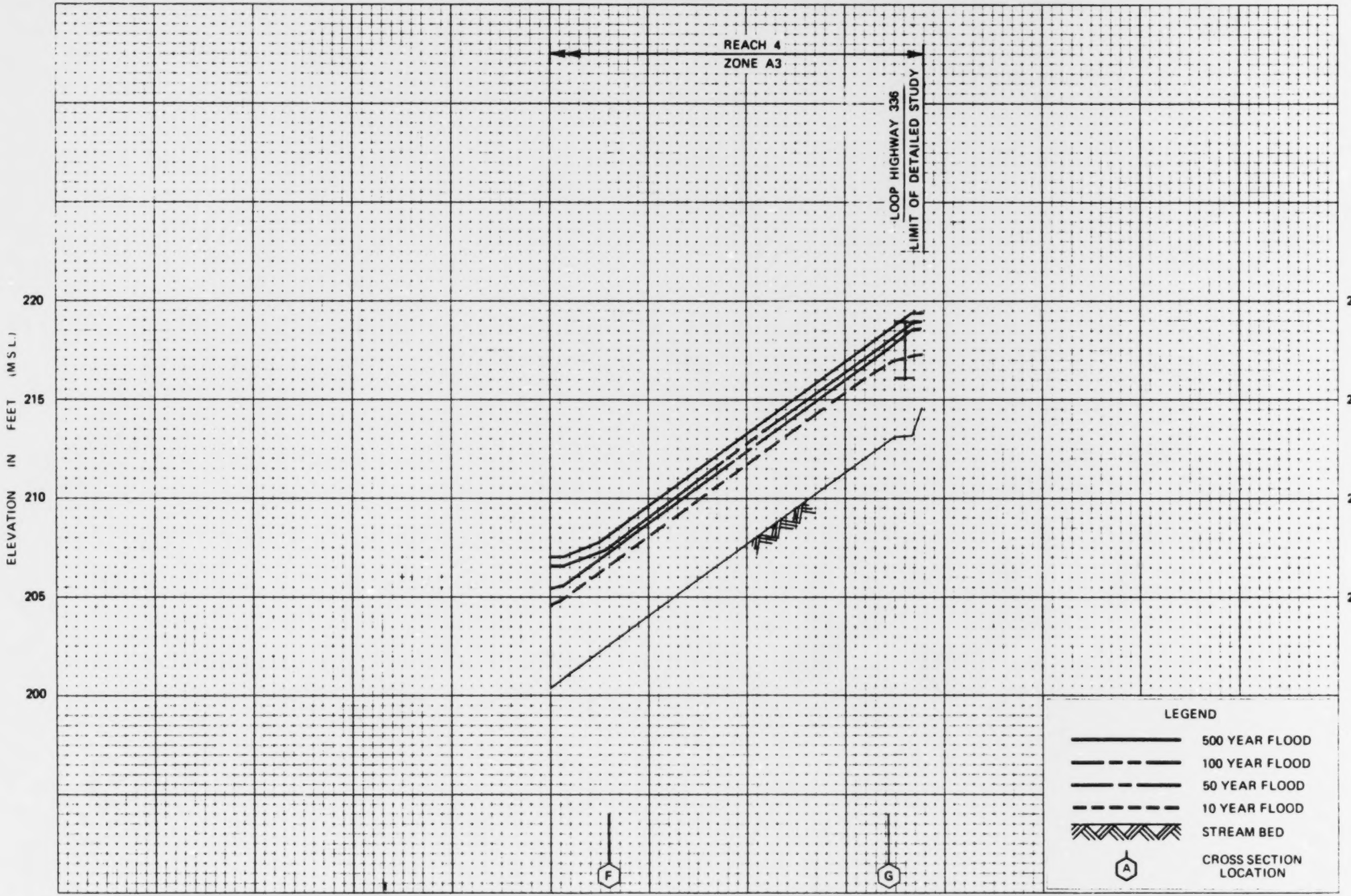

FLOOD PROFILES

WEST FORK, WEST BRANCH ALLIGATOR CREEK

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CITY OF CONROE, TX
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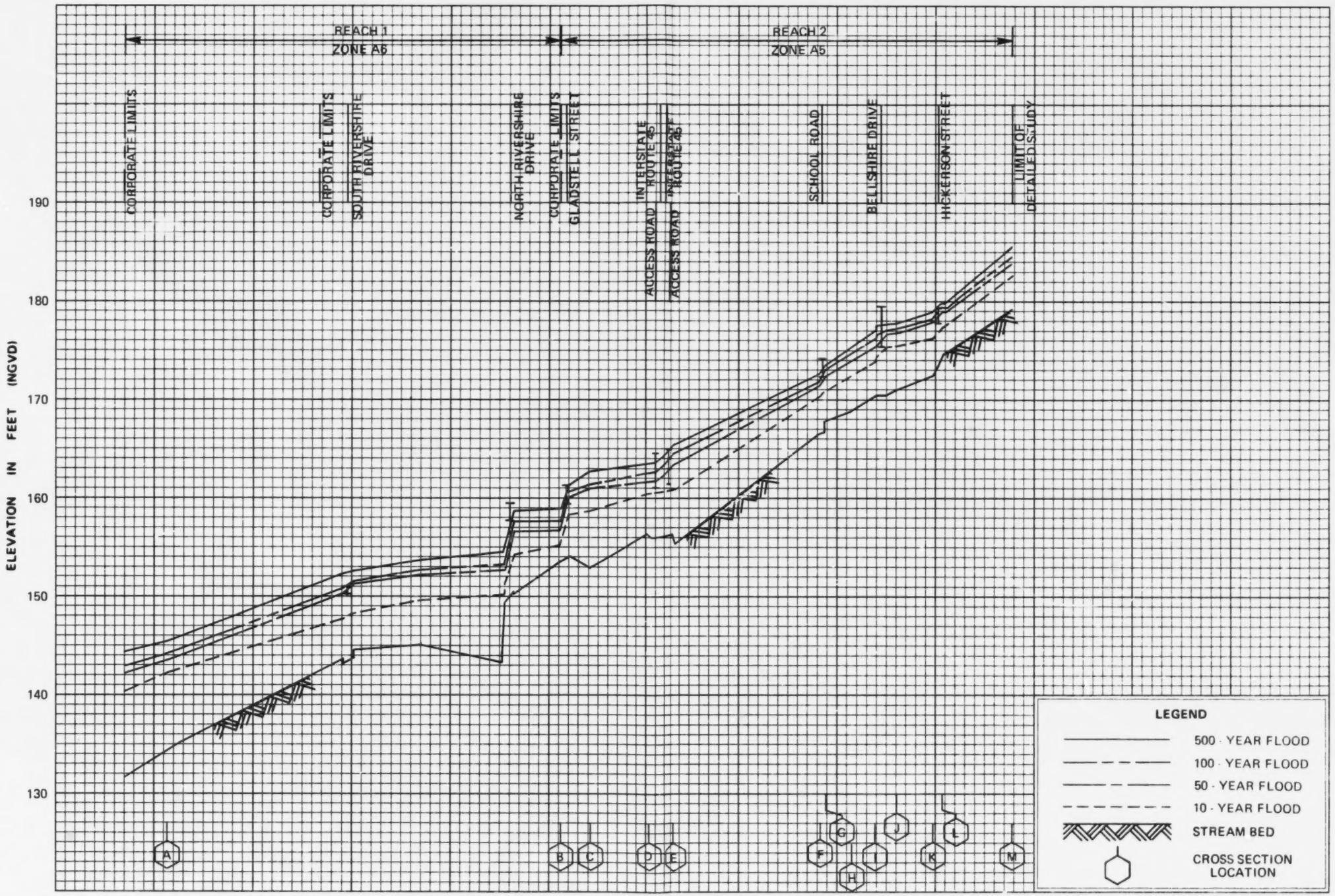

FLOOD PROFILES

GRAND LAKE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX
(MONTGOMERY CO.)

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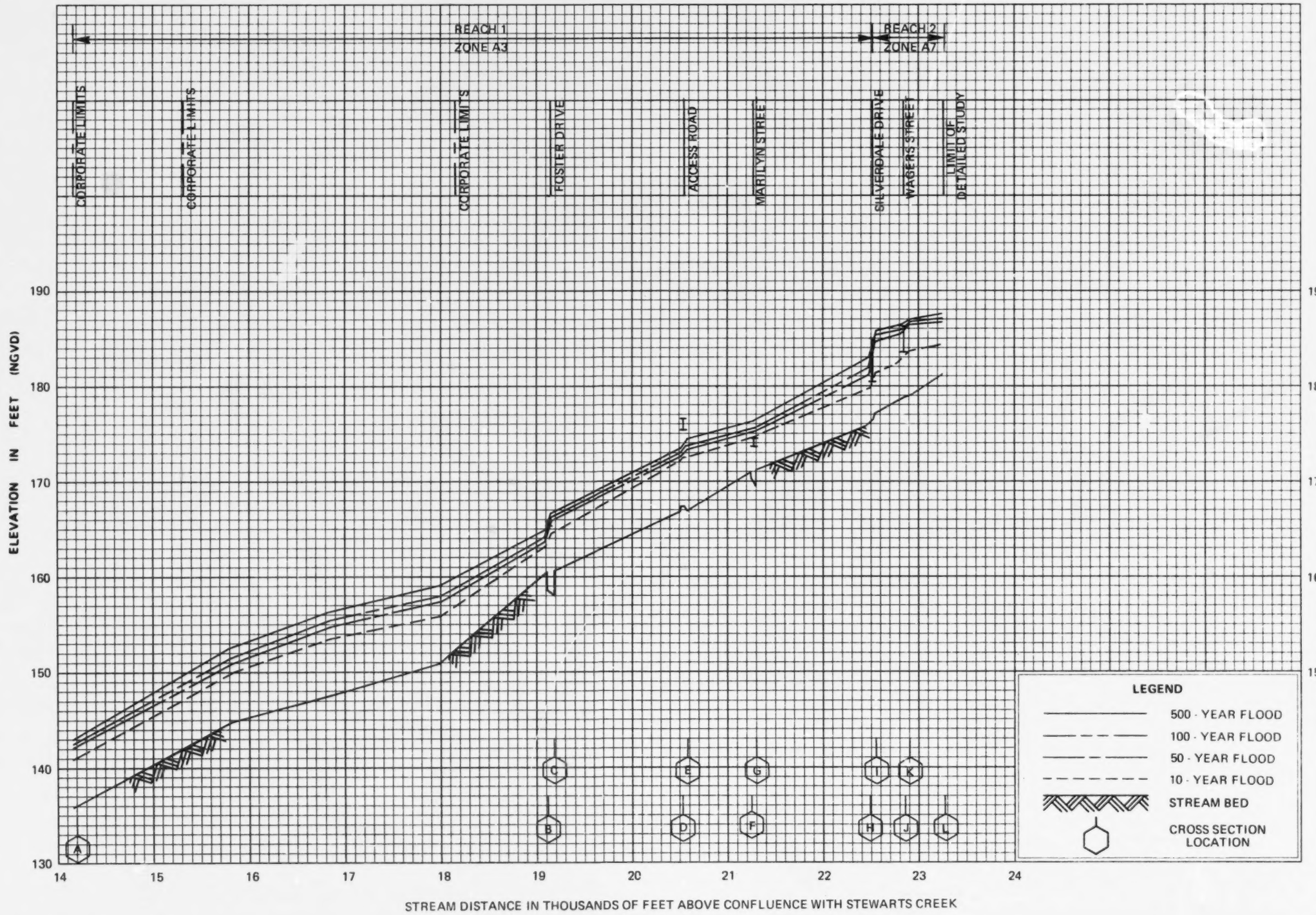

FLOOD PROFILES

SILVERDALE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX
(MONTGOMERY CO.)

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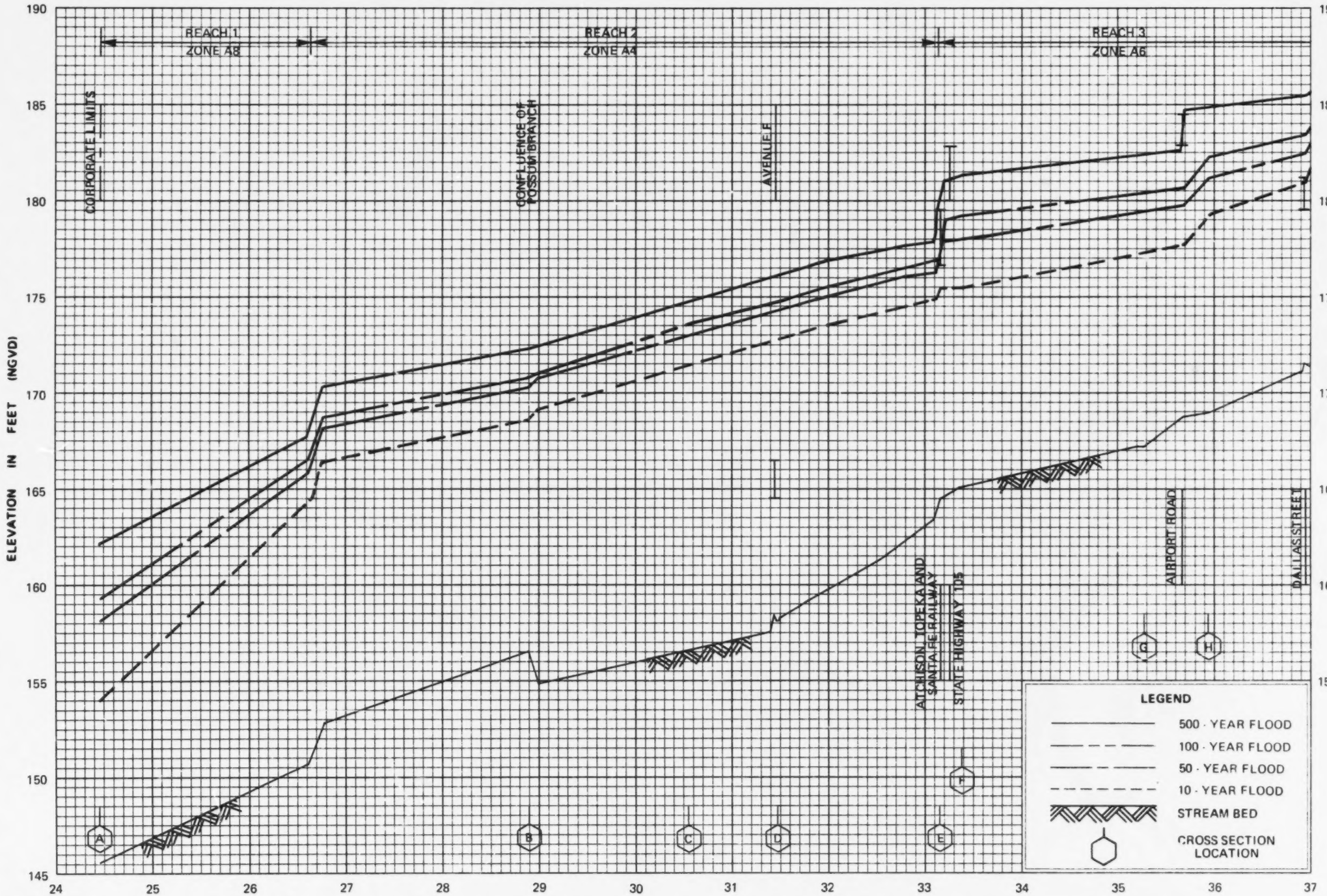

FLOOD PROFILES

STEWARTS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX
(MONTGOMERY CO.)

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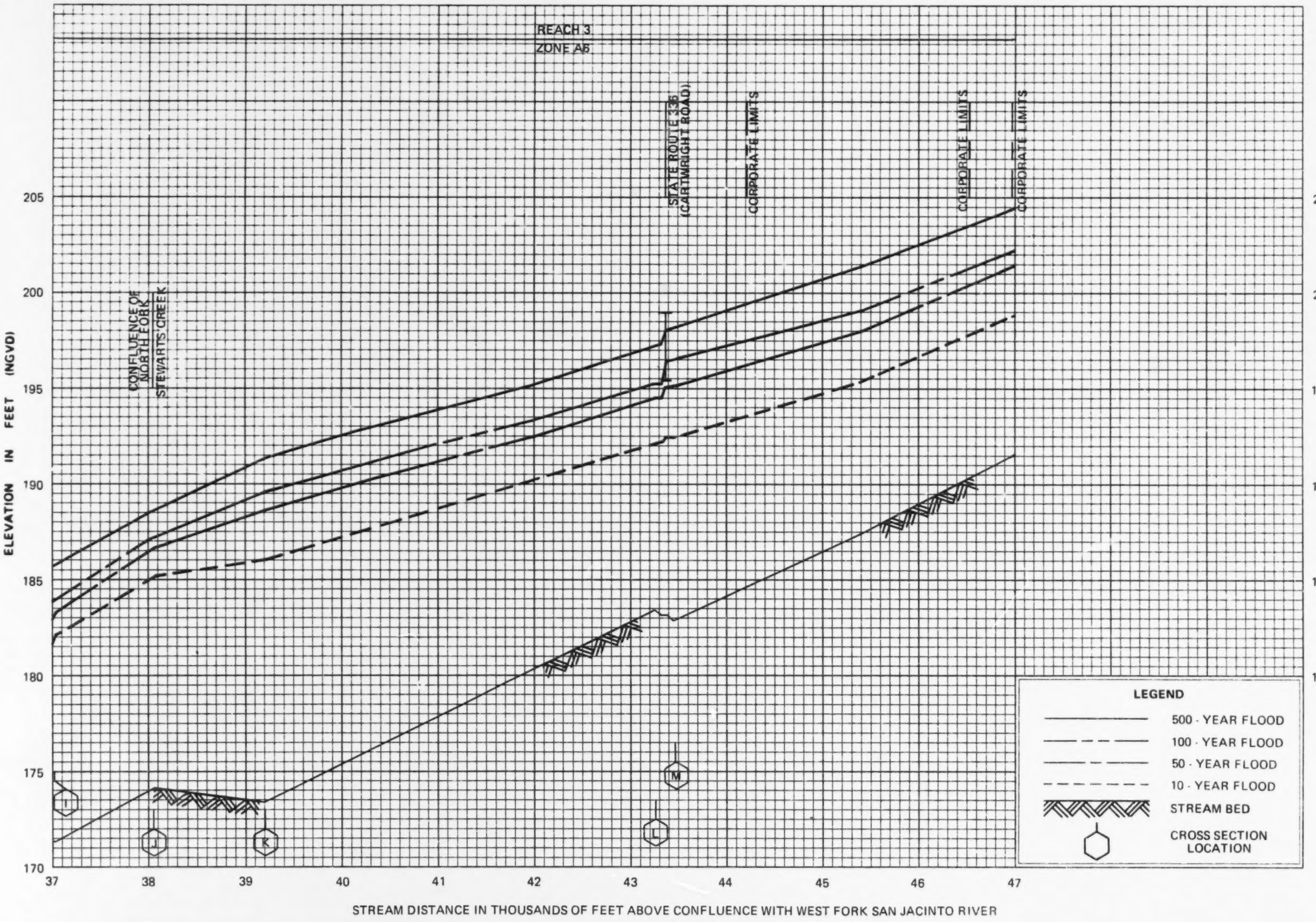

FLOOD PROFILES

STEWARTS CREEK

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CITY OF CONROE, TX
(MONTGOMERY CO.)

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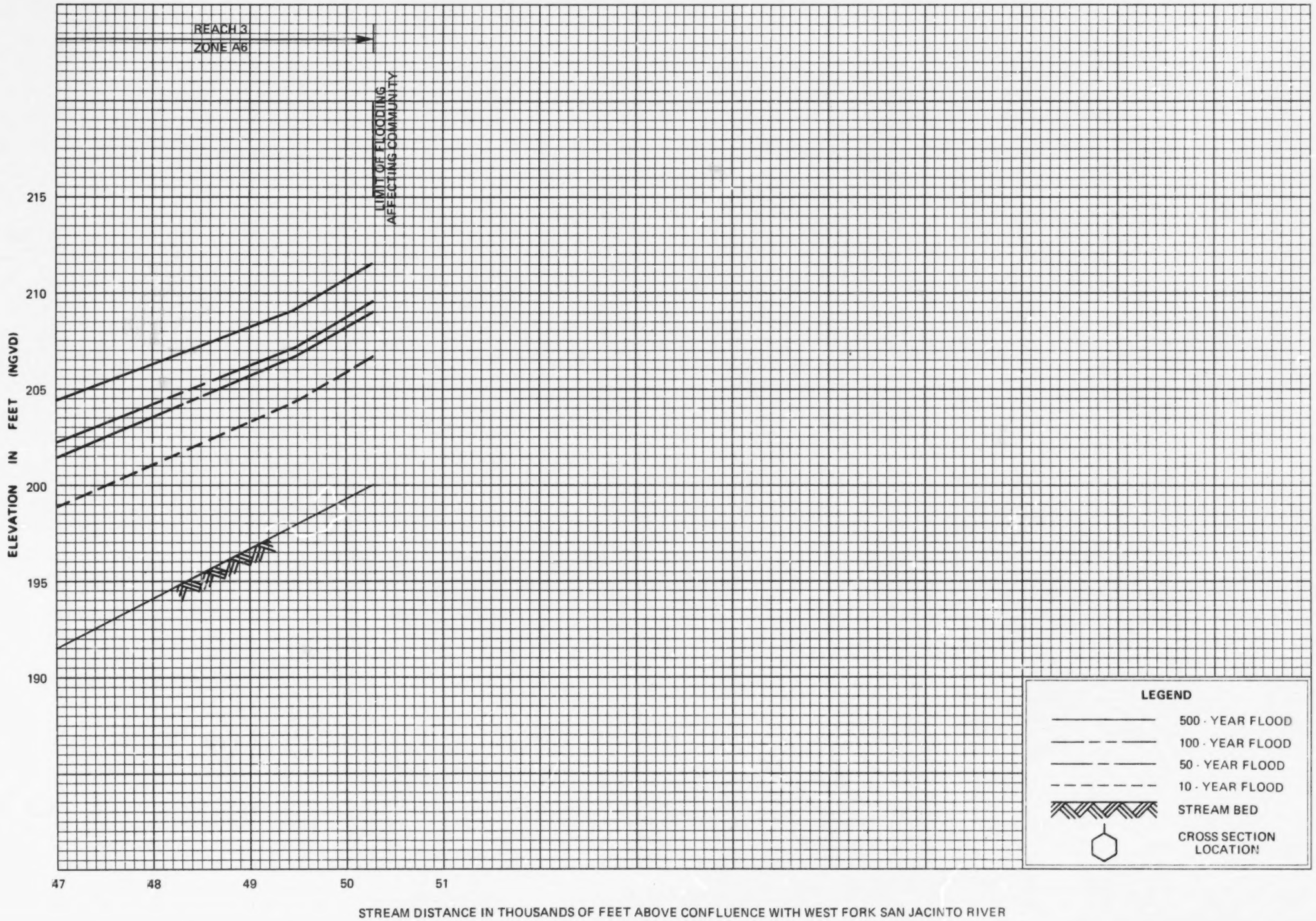

FLOOD PROFILES

STEWARTS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX
(MONTGOMERY CO.)

14P

39

39

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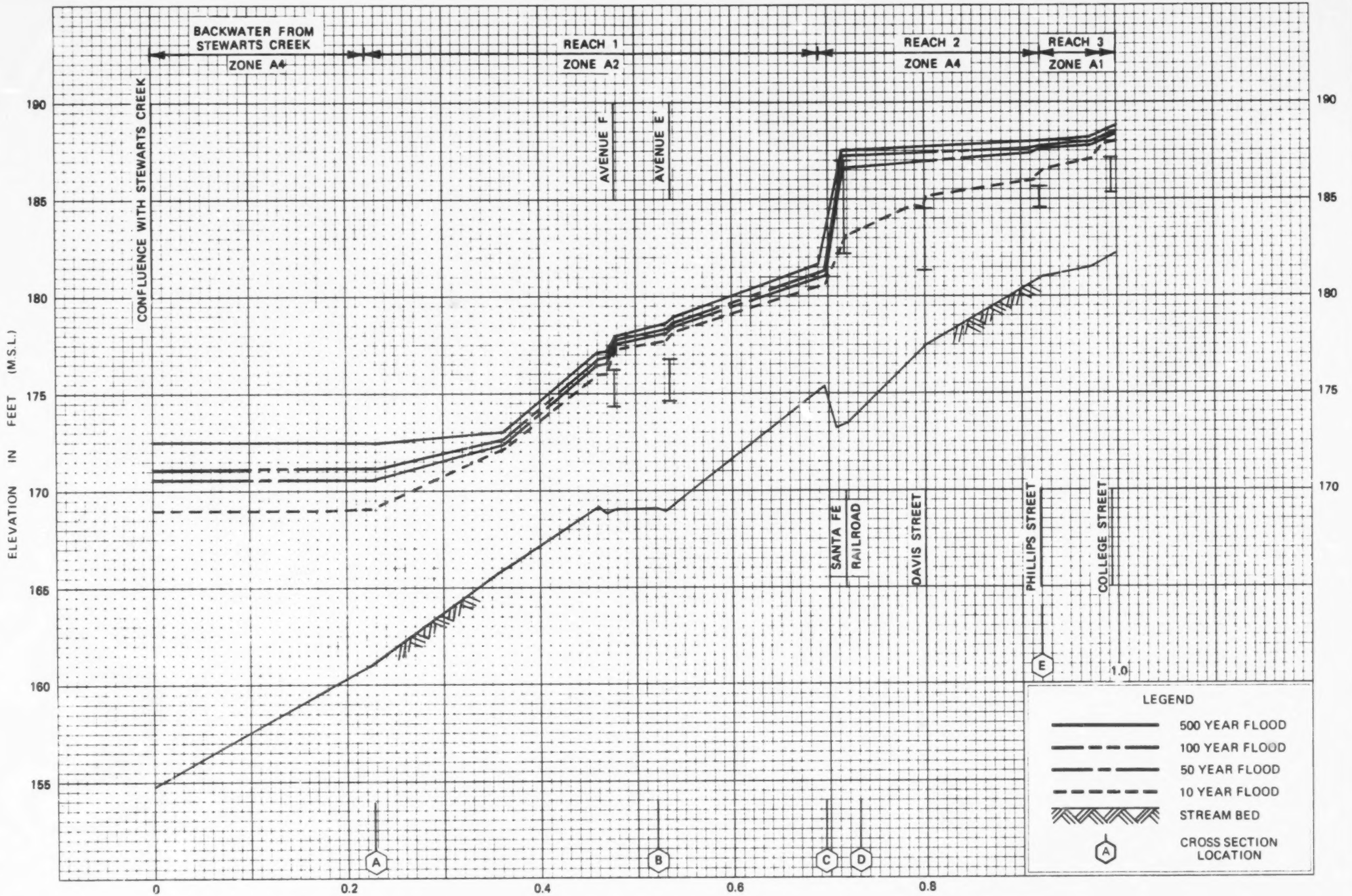

FLOOD PROFILES

POSSUM BRANCH

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF CONROE, TX
(MONTGOMERY CO.)

15P

40

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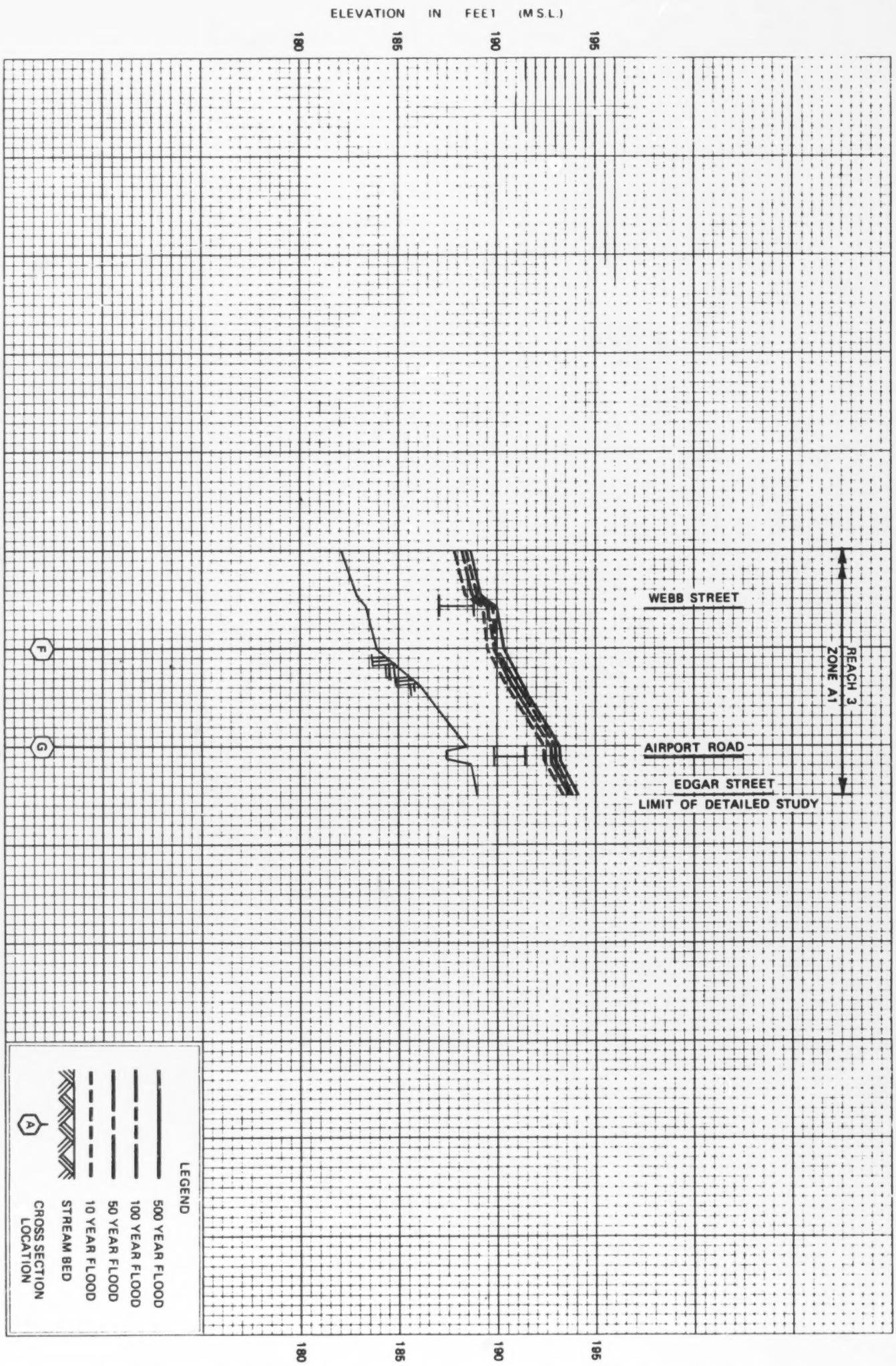

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF CONROE, TX
(MONTGOMERY CO.)

16P

FLOOD PROFILES

POSSUM BRANCH

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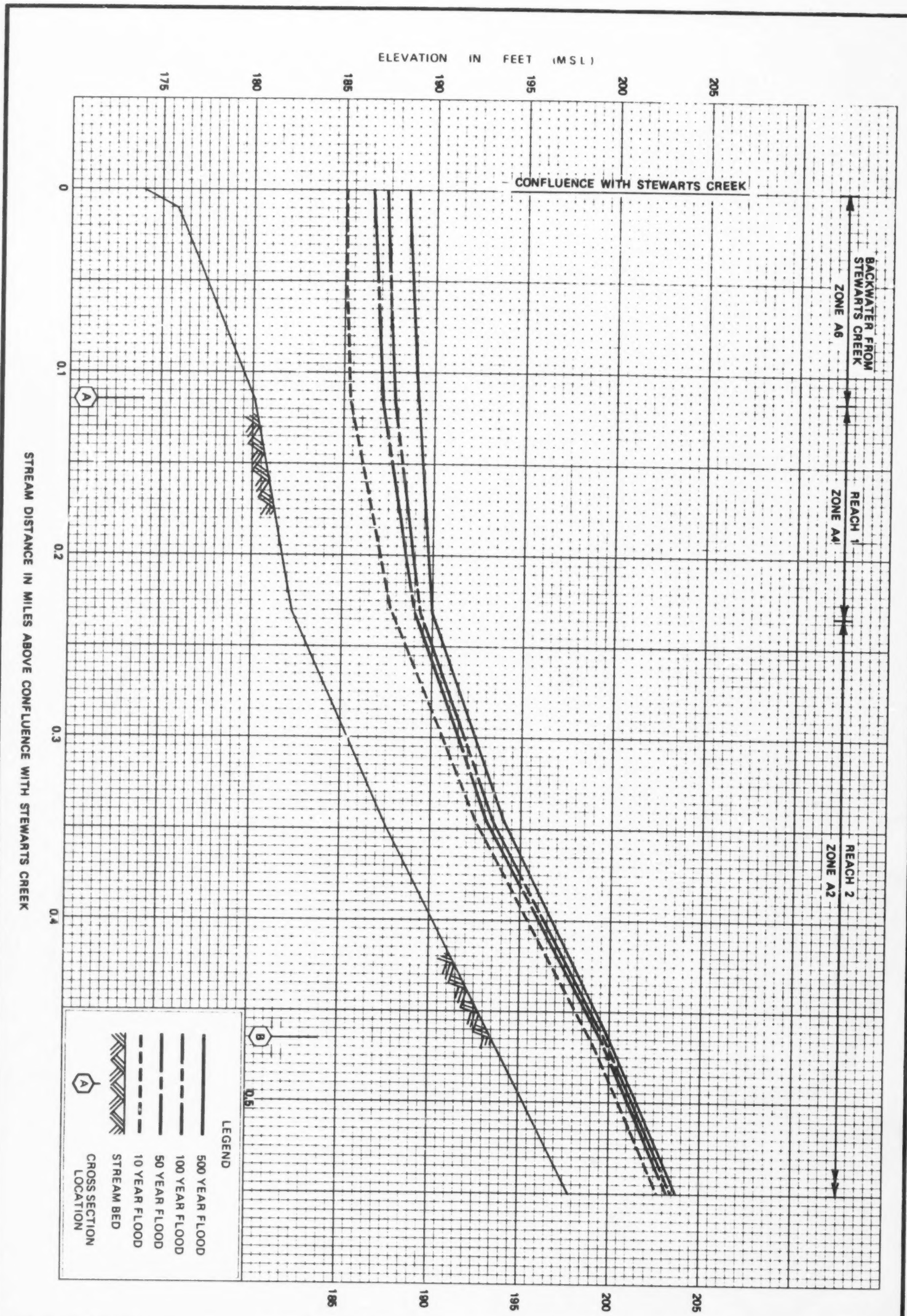

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF CONROE, TX
(MONTGOMERY CO.)

17P

FLOOD PROFILES

NORTH FORK STEWARTS CREEK

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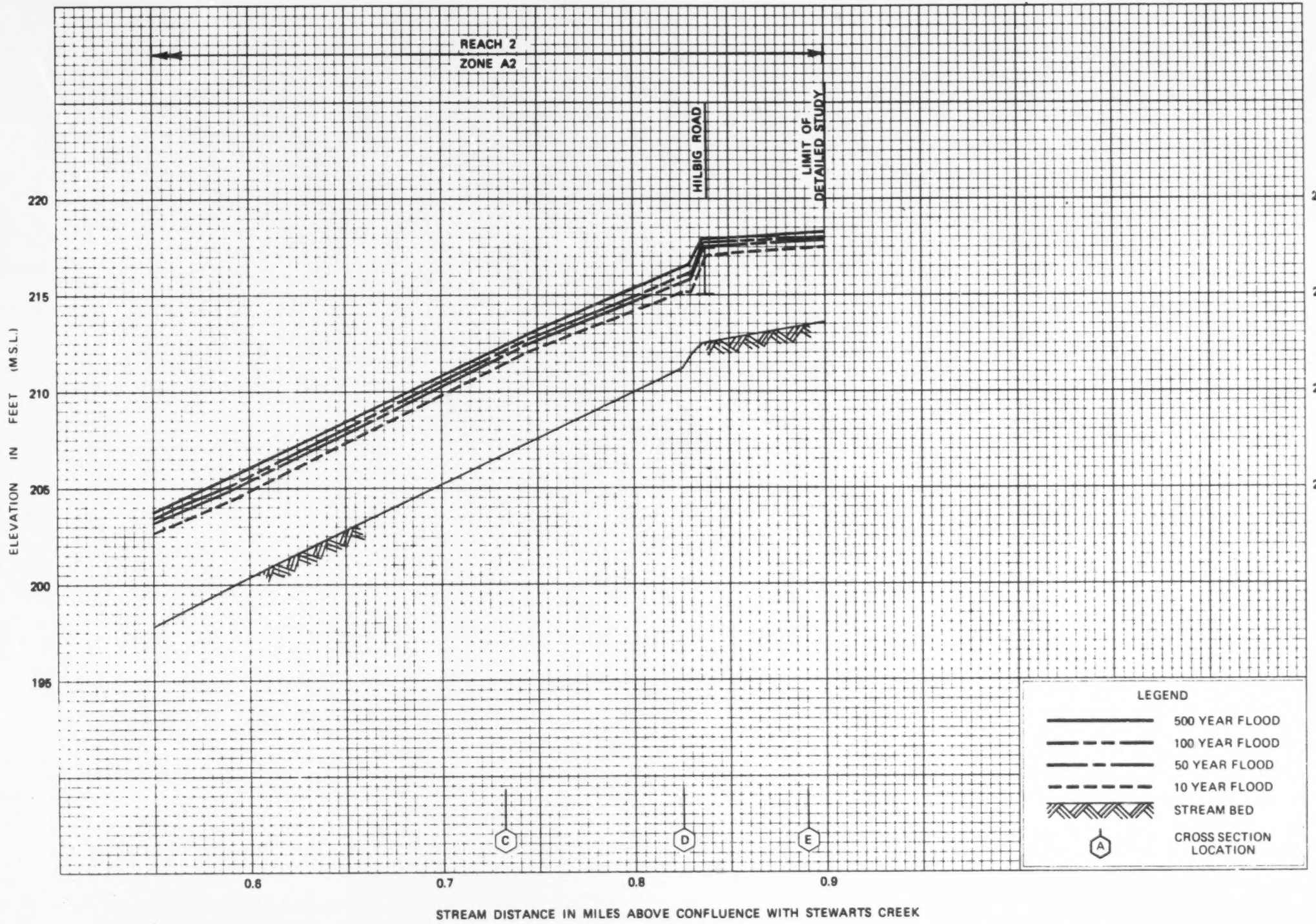

FLOOD PROFILES

NORTH FORK STEWARTS CREEK

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF CONROE, TX
(MONTGOMERY CO.)

18P

43

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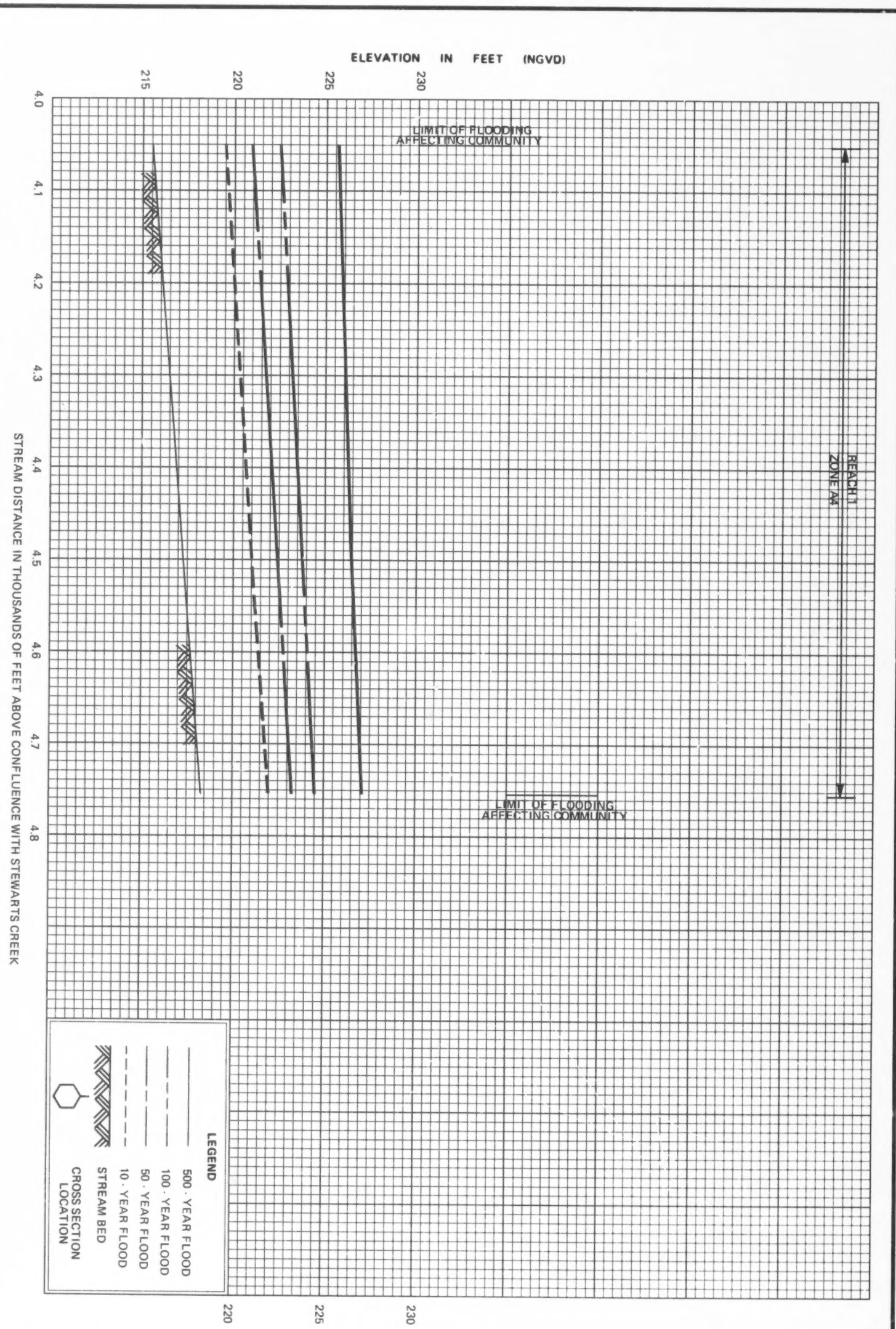
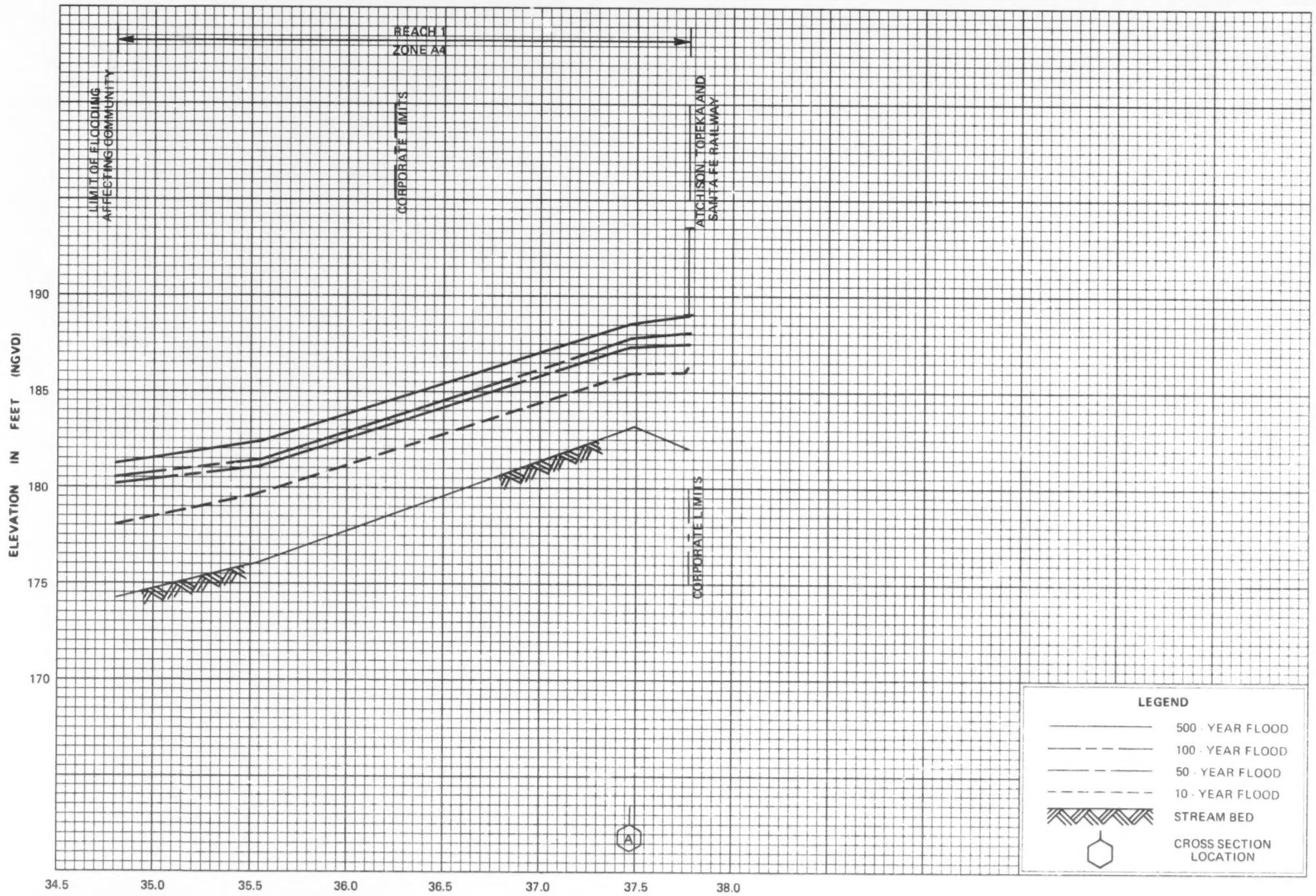


19P	FEDERAL EMERGENCY MANAGEMENT AGENCY **CITY OF CONROE, TX** MONTGOMERY CO.)	**FLCOD PROFILES** **STEWARTS CREEK TRIBUTARY NO. 1**



FLOOD PROFILES

LITTLE CANEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF CONROE, TX
(MONTGOMERY CO.)

20P

45

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